THE

ELECTRICAL REVIEW.

VOL. XLVII. OCTOBER 5, 1900. No. 1,193.

CONTENTS:

	PAGE
Earthing Electric Light Mains	529
The Paderno Electric Power Station (*illustrated*)	531
Three-Phase Alternator by Ganz & Co. (*illustrated*)	532
Mr. Heather's Paper on the Electric Transmission Plants at Moodie's Gold Mines	533
The Limitations of Block Signalling	534
New Form of Calorimeter...	534
Current Specifications.—XXXI.	535
Increase in the Use of Gutta-Percha in Electric Cable Building	536
Our Legal Query Column	537
Measurement of the Resistance of Cables (*illustrated*) ...	537
Correspondence:—	
The Bradford Dust Destructors	539
Wireless Telephony at Sea	539
Meter Systems...	539
Gas *v.* Electric Driving	539
Annealing Stampings...	539
Interior Wiring	540
Prof. Thompson's Lecture at Bradford	540
The Cummins Water-Tube Boiler	540
Ions, Atoms, and Electrons	541
The Synchronisation of Alternators Coupled in Parallel (*illus.*)	543
Business Notes	544
The New Electricity Works of the Glasgow Corporation (*illustrated*) (*continued*)	546
Supply Station Accounts	557
City Notes	557
Traffic Receipts	558
Stocks and Shares	558
Share List of Electrical Companies	559
Market Quotations	560
Metal Market.—Fluctuations in September	561
British Association for the Advancement of Science:— Small Screw Gauge	561
Power Generation: Comparative Cost by the Steam Engine, Water Turbine, and Gas Engine (*concluded*)	563
Progress in Arc Lighting by Alternating Current Lamps (*illus.*)	564
Steel: Its Properties and Tests.—IV.	566
Feed Pump Efficiencies	567
New Patents	567
Abstracts of Published Specifications	568

THE

UNIVERSAL ELECTRICAL DIRECTORY

1900

Edition.

H. ALABASTER, GATEHOUSE & CO.,

4, Ludgate Hill, London, E.C.

THE ELECTRICAL REVIEW.

Published every FRIDAY, Price 4d.

The Oldest Weekly Electrical Paper. Established 1872.

TO BE OBTAINED BY ORDER FROM ANY NEWSAGENT IN TOWN OR COUNTRY.

OFFICE:—4, LUDGATE HILL, LONDON, E.C.

Telegraphic Address: "AGREKAY, LONDON." Code, A B C.

Telephone No. 933 Holborn.

ALL Letters should be addressed to the Proprietors, H. Alabaster, Gatehouse & Co.

ADVERTISEMENT RATES ON APPLICATION.

The "Electrical Review" is the recognised medium of the Electrical Trades.

SUBSCRIPTION RATES.—In Great Britain, Post Free per Year, 19s. 6d. To all other countries, per Year, £1 10s.

BINDING.—Subscribers' numbers bound, including case, for 4s. each volume.

CASES.—Cloth Cases for Binding can be had, price 2s. 6d. each.

READING CASES, to hold from One to Twenty-six Numbers until the volume is complete for Binding, can now be had from the Publishers, Price 6s., or Free by Post (in Great Britain), 6s. 6d.

FOREIGN AGENTS.—New York: D. VAN NOSTRAND, 23, Murray Street. Paris: VEUVE J. BOYVEAU, 22, Rue de la Banque. Berlin: ASHER & Co., 13, Unter den Linden

Cheques and Postal Orders (on Chief Office, London), to be made payable to Mr. H. ALABASTER, 4, Ludgate Hill, E.C.

EARTHING ELECTRIC LIGHT MAINS.

THERE has recently been a good deal of discussion on the question of the earthing of electric light and power mains, not only in this country but also in the United States. A committee of the National Electric Light Association has been considering the question, and has recently published a report recommending the earthing of the neutral wire of low-tension, three-wire, direct-current systems, on the ground that the risk of fire is greatly decreased thereby. It would appear from this report that nearly all the American fire offices look upon the earthing of the neutral as an extremely dangerous practice, and one which greatly increases the fire hazard, but the committee somewhat sarcastically remarks that those who have more practical experience take the opposite ground, and states that in spite of the fire offices, it is the almost universal practice to permanently earth the neutral wire.

In England the earthing of the neutral wire has been chiefly discussed in connection with three-wire systems with 200—250 volts between neutral and outers, and has been advocated principally with the object of keeping the maximum potential difference between any conductor and earth below 250 volts. In America, however, the three-wire system is still covered by the Edison patent, and is almost always worked at the standard pressure of 110 volts between neutral and outers, and 220-volt lamps have chiefly been used on two-wire systems, with the object of obtaining the benefits of the Edison three-wire system without infringing the patent.

The report also recommends the earthing of one wire of the secondary circuits of step-down transformers. It appears that in America a number of deaths and fires have been caused by the failure of the insulation between the primary and secondary coils of transformers, and by the passage of the primary current over the secondary circuits. In this country, on the other hand, although it has been by no means an unknown thing for the primary current to get on to the secondary winding, there have not been many serious accidents to the public from this cause. In the United States, transformers are often fixed on poles, or on the roofs or walls of houses, and the committee states that it has been found almost impossible to effectively earth the cases of such transformers. It regards an "earthing device" connected to the secondary as a snare and a delusion, and expresses the belief that the permanent earthing of one wire of the secondary circuit, though not an absolute preventive of accidents, will greatly reduce the danger to the public from high tension transmissions.

Wireless Telegraphy in the Mediterranean.

Recently some very practical experiments in connection with Captain Jackson's system of wireless telegraphy were carried out in the Mediterranean. The fleet was divided into two portions, so as to represent two fleets, the one being strong in battleships, and the other having fewer battleships, but a superior squadron of cruisers, destroyers, and torpedo boats. The operations were carried out in the immediate vicinity of the island of Lemnos. The hostile fleet were known to be starting from Dideagatah, a port on the southern coast of Turkey in Asia; they were the superior in battleships. The inferior or friendly fleet, which possessed more cruisers, lay in Port Moudros, which takes a large bite out of the southern coast of Lemnos Island, running up well into the interior of the island. The *Vulcan*, which formed one of the cruisers of the Lemnos squadron at the commencement of hostilities, took up a position about 10 miles north of the island, remaining under weigh, and receiving all information obtained by the other cruisers who were scouting to the northward and transmitting it by wireless telegraph right across the Island to Port Moudros, where their battleships lay. Thus the friendly fleet lay snugly at anchor entirely hidden from view, and all the time receiving reports from their cruisers through the *Vulcan*. On the fourth day of the manœuvres the hostile fleet were located in force to the North of the Island, the scouting cruisers were signalled to close and the enemy thereupon gave chase, the battleships from Lemnos waited until the cruisers had led the enemy fairly close, and then out they came from their hiding place. Then ensued a battle royal between both fleets in force. Had it not been for the wireless telegraph the probability is that the cruisers would have been driven into Moudros Harbour to their own battleships, and the enemy would thus have been able to establish a blockade to their advantage. The distance over which the *Vulcan* telegraphed was not strained, the object being chiefly to point out certain circumstances under which the use of a wireless system became invaluable, and it was generally considered that this was thoroughly well demonstrated.

Electrolytic Methods of Quantitative Analysis.

Quantitative analysis by means of electrolysis has failed to become as popular amongst analysts as Classen, the pioneer of this method, anticipated. His work, "Quantitative Analyse Durch Electrolyse," has, until comparatively recently, remained the only classic on the subject. Within the last few years, however, many have turned their attention to it, anticipating that the methods of electrolytic analysis were capable of extension and development, and appeared likely to be extremely useful in adding to our knowledge. Indeed, in 1894, the British Association appointed a strong Committee to collate existing results and to carry on researches on the subject. Six reports have now been issued, and the labours of the committee have included a complete bibliography on electrolytic analysis, which alone would justify its existence. A great deal of experimental work has been carried on by various members of the committee, and the latest results were recently published at the Bradford meeting of the British Association; this report concludes their work. Most of this report is of interest chiefly to chemists, and for the details we must refer them to the *Proceedings*. The chief results, however, were the following:—Bismuth can be determined electrolytically with accuracy in simple and dilute solutions containing citric acid and even relatively large proportions of free nitric and sulphuric acids; but its electrolytic separation from any of the metals with which the committee have experimented cannot be recommended. In all cases in which the determination of very small quantities of iron in organic products is concerned, the exceptional delicacy of the electrolytic method, its freedom from the sources of error that arise with other methods on account of the inherent presence of salts and of organic matter, and, finally, the ready check on the nature and amount of the deposited metal, render it capable of giving reliable and comparable results under all conditions.

British Association Screw Threads.

In another column we are printing the report presented at Bradford by the British Association Committee on the Small Screw Gauge. The matter has been under consideration for a number of years, and now definite recommendations are made. The advantages of the form of thread recommended are undoubtedly great, but it is unfortunate that what is in the main the same committee should have given the advice upon which we have all acted for the last 15 years, and which is now pointed out to be seriously defective. The committee are alive to this point of the case and propose to show practically that the change would cause no inconvenience, since the new threads will be, in practice, interchangeable with the old. If they can do this, it is to be hoped that the new threads will come into use, since, from the point of view of mechanical design, they are distinctly in advance of the old ones. The committee, as now constituted, is a strong one, and appears to have gone into the matter very thoroughly.

Resistance of Road Vehicles to Traction.—A paper on this subject presented to the Bradford meeting of the British Association by Prof. Hele Shaw, points out that on French roads speeds of 40 and 50 miles per hour have recently been achieved, and even maintained for a distance of 300 miles. The same is possible in this country, though it is illegal. With heavy traffic, however, 2-ton vehicles are limited to 8 miles per hour, and with 3-ton vehicles 5 miles is the limit in law. We venture to think that such speeds are often exceeded by their drivers—sometimes unknowingly. A speed of 6 miles per hour appears to be a mere crawl if one be upon an electric tramcar. Years ago the tractive resistance of vehicles was made the subject of investigation by Morin, Tredgold and others, but little has been done to supplement their work, more especially since the use of soft tires has demanded that fresh figures ought to be now obtained. The author recently made some such attempts with speed indicators and traction dynamometers, but he has no results to produce of any value, as he had employed very imperfect apparatus. This paper appears to be a preliminary only, as it was announced that application was to be made to the British Association for funds to continue the investigations. If they are to be made, one would advise the employment of steadying devices, such as oil dashpots, in order to take the angles out of the records. We think also that dynamometers that depended for their action on hydraulic transmission of pressure would possibly be found most useful, and that much might be learned of road resistance by allowing vehicles to drift by gravity down hills of carefully measured inclination, and comparing their velocities after different lengths of run, with that attained by an entirely frictionless or ideal vehicle drifting in the same way. Obviously, the amount by which the velocity gained in one second fell below the theoretical value would be a measure of the resistance due to air and friction. By means of stakes, an accurately running record ribbon and a press-button, the speed at passing each stake could very readily be taken. It would be better that the tachometer should show neither miles per hour nor revs. per minute, but that it should indicate feet per second, and while we think highly of the tachometer, we should prefer the speed indicator to record on a ribbon. It is difficult to get these ribbon indicators to run evenly at quick paper speeds. For regularly organised tests, it might be better to allow the paper ribbons to be driven by the axle of the vehicle, so as to give a measure of the space passed over, while the time might be recorded by a press-button on the ribbon, either autographically or by an observer with a watch.

THE PADERNO ELECTRIC POWER STATION.

In one of the pictures accompanying this article we give a view of the generating station at Paderno, on the River Adda, the current from which is being transmitted to Milan, a distance of 32 kilometres, for the purpose of running the tramways and the lighting of that city.

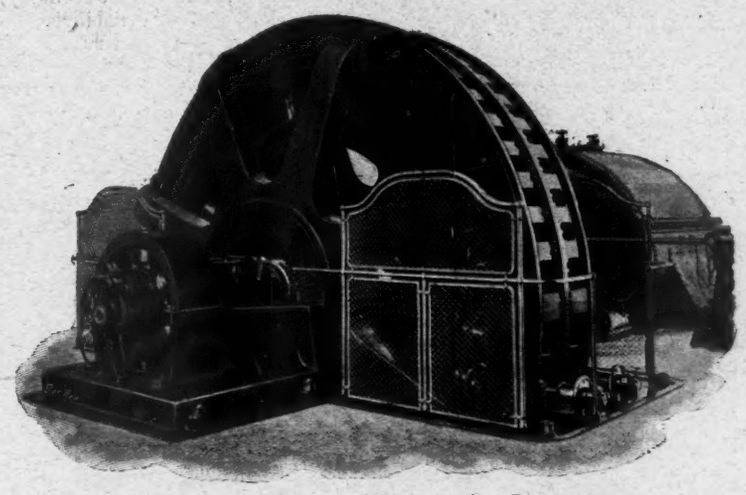
Readers may remember that this plant is unique in that the three-phase currents are generated at 13,500 volts, thus avoiding the use of step-up transformers. Another feature of interest is that this fine station, containing 13,000 H.P. of generating plant, and another at Porta Volta, which will have 12,000 H.P., has been laid down by a company—the Edison Company—for a city of less than half a million population, or, say, the size of Birmingham. Further, the municipality own the tramways track, which is over 93 kilometres (60 miles) in length, and the fares are only 5 centimes from 7 to 9 a.m., and 10 centimes afterwards, or, say, $\frac{3}{8}$d. and $\frac{3}{4}$d. respectively.

The water for the power station is taken through a head sluice having six iron penstocks, and is carried through a concrete-lined conduit 2,268 metres long, having two open cuts of 230 and 352 metres, and three tunnels 405, 270, and 1,005 metres each, giving finally a head of 29 metres. The conduit delivers 45 cubic metres of water per second, the rate of flow being 2·7 metres per second, this corresponding to about 13,000 effective horse-power at the alternator terminals.

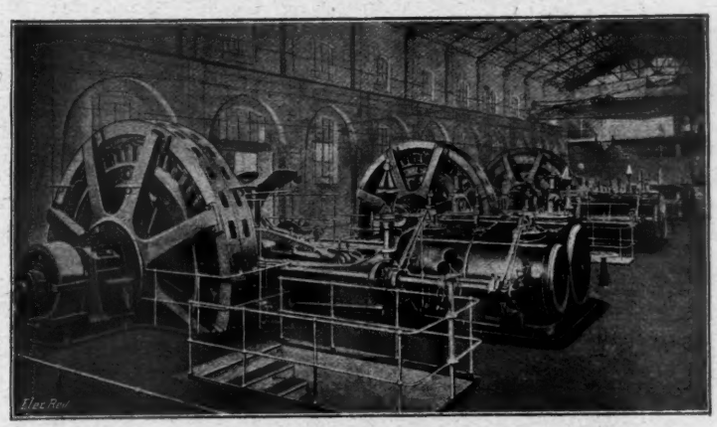
Turbines.—Seven in number, by Riva & Monneret, of Milan, are of the tangential central discharge type, with bucketed wheels, arranged in pairs upon a horizontal shaft. The water is received at the periphery and discharged inwards, and on account of the variation of water level in the river, the wheels run under a constant pressure head of 23 metres, the remaining 6 metres of fall acting by suction.

The highest variation of speed is 2 per cent. in ordinary work and 4 per cent. when the load is suddenly increased or diminished by 25 per cent. This is effected by a Ganz & Co. hydraulic governor, which is practically an hydraulic engine with two pistons controlling a ring which, by moving tongues, expands or contracts the area of the admission channels. In addition there is a regulator consisting of a small electromotor, which can be moved in either direction from the switchboard. The efficiency is 82 per cent. The turbines are connected to each alternator through an electric coupling.

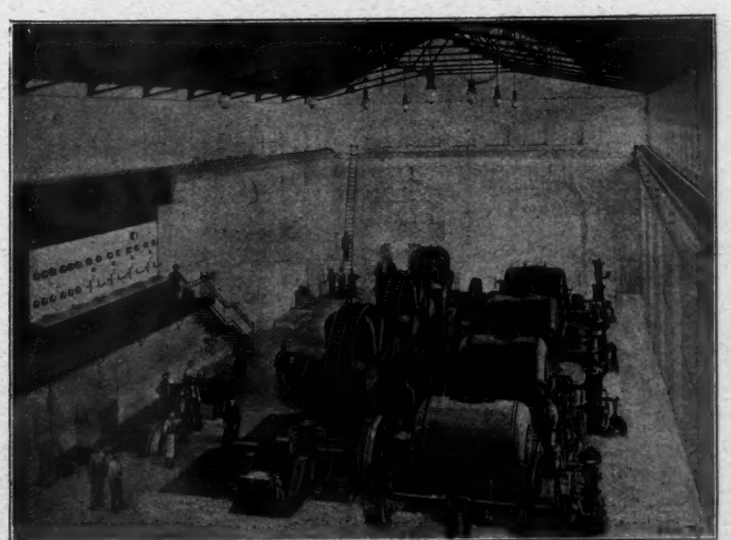
Alternators.—Seven Brown-Boveri three-phase machines, each 2,160 H.P., 13,500 volts, 42 periods, 180 revolutions. The steel fly-wheel carries 28 laminated poles, each wound Ferranti fashion, with bare copper 3 × 32 mm. on edge, and insulated with paper. The armature, 4·1 metres diameter, has its windings completely enclosed by thick micanite tubes, which project 10 cm. beyond the iron to guard against discharges to the framework. In order to keep the coils at a sufficient distance apart at their ends, one coil is brought straight out, and another is bent outwards, and the third bent inwards. It would not be possible, therefore, to draw the armature along parallel with the shaft. Provision is, however, made for inspecting the coils and thoroughly cleaning them—a most important matter for such a high voltage—by the whole armature being capable of being



2,160 H.P. ALTERNATOR (13,500 VOLTS) AT PADERNO.



PORTA VOLTA CENTRAL STATION, MILAN. THREE-PHASE ALTERNATING CURRENT AT 3,600 VOLTS.



PADERNO GENERATING STATION.

rotated by a rack on its outer periphery. It will be noticed from fig. 2 that the Brown alternator armature frame is carried on the bearings, thus giving a perfect method of centreing.

The internal reaction does not exceed 5 per cent. on non-inductive load and 16 per cent. on inductive load, with power factor of 0·80, the efficiencies being 95 per cent. and 93 per cent.

Transmission Line.—Six three-phase lines, or 18 wires in all, each being 9 mm. diameter. Two pole lines, that is, nine wires on each pole, arranged five on one side, and four on the other. The distance between any two wires is 600 mm., and between any two wires of the same phase 1,039 mm. Average span 60 metres, the sag varying from 0·60 m. in winter to 1·20 m. in summer. Drop of volts due to resistance and self-induction of line and transformers 12½ per cent. Repairs on the line are very simply carried out by putting all the load on to one set of nine wires, the voltage at the generators being temporarily raised to allow for the greater drop.

Poles.—Masts of lattice iron 10 metres high, each weighing 400 kg., set in concrete. At angles the two poles are connected by diagonal cross-bars. Rent is paid by the Edison Company for the ground traversed by the posts.

Lightning Arresters.—Both Wurtz non-arcing metal rollers, and the Siemens & Halske horn type.

Porta Volta Auxiliary Station.—Besides the main station there is an intermediate transformer and auxiliary power station at the Porta Volta, at the city boundary. Here there are two 225-H.P. and three 1,000-H.P. steam-driven alternators, generating current at 3,600 volts. There are also 14 step-down 350-KW. Ganz transformers, reducing pressure from about 12,000 to 3,500 volts.

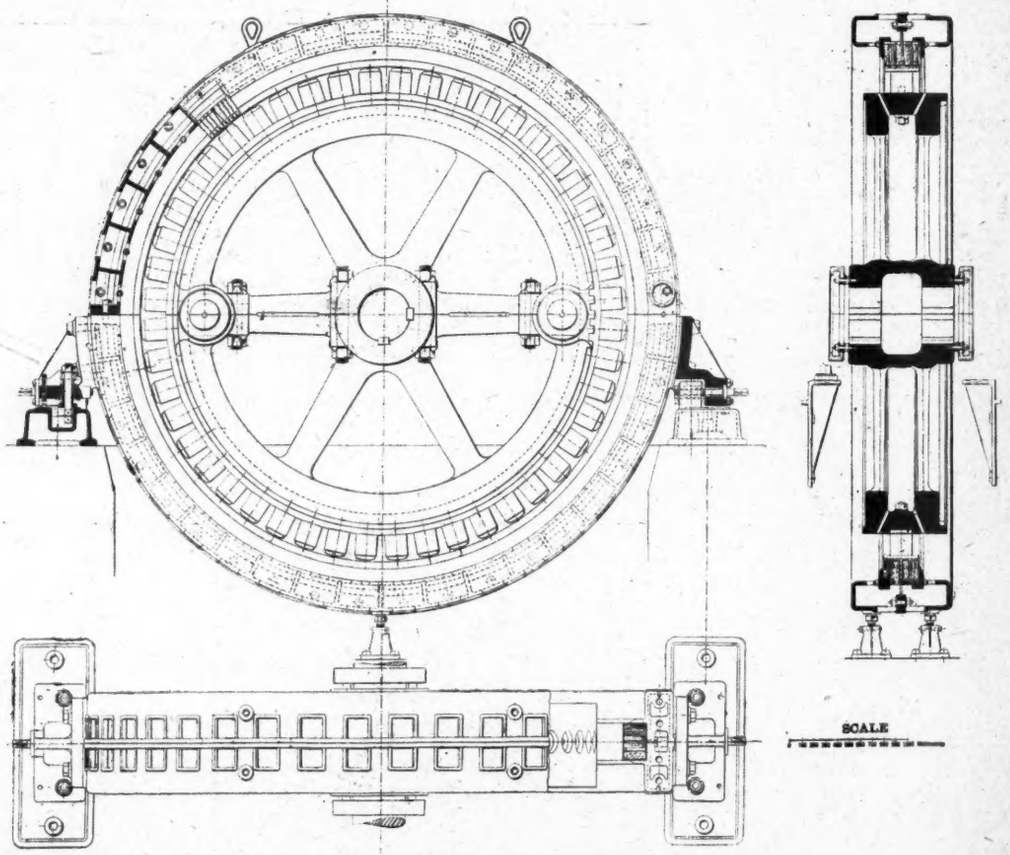
Sub-station.—The sub-station proper is at Santa Radegonda, near the cathedral square. This contains four motor-generators, each of 500 KW. 500 volts for the tramways, two of 250 KW., and two of 60 KW. for the three-wire lighting network at 110 volts. The dynamos in each case are driven by asynchronous motors at 3,500 volts.

THREE-PHASE ALTERNATOR BY GANZ AND CO.

BELOW we give a detailed drawing of a large three-phase alternator which is to be seen in the Hungarian Section at the Paris Exhibition. This alternator by Ganz & Co. gives 1,200 KW. at 2,200 volts, and is driven by a compound horizontal condensing engine, by L. Láng, of Buda-Pesth, running at 125 revolutions per minute. The alternator has 48 poles for a frequency of 50 complete cycles per second. The iron of the armature core is 0·5 mm. thick, the bore 13¾ feet, and the conductors are wound through micanite tubes, a feature of the machine being that there are 2½ slots per pole per phase. The exciter is driven by a link from the crank of the engine, its output being 200 amperes 90 volts. Working on an inductor load of 0·7 the increase of voltage on breaking the current of the generator increases about 15 per cent. if the speed and the voltage of exciting is kept constant. On a non-inductive load the augmentation of voltage would be only 5 to 6 per cent.

When giving the full output of 1,200 KW. on an inductive load of 0·7, the temperature of any part of the machine will not exceed 35° C. above that of the surrounding air.

The total weight of the alternator is 43½ tons, of which the field magnet system accounts for 21¾ tons.



THREE-PHASE ALTERNATOR BY GANZ & CO.

Messrs. Ganz & Co. have a most extensive exhibit, ranging from electric overhead travellers to small induction motors and measuring instruments. A particularly interesting instrument is the Hoór "slipmeter," which enables a careful observer to measure the slip of single and polyphase motors.

The group of original apparatus is particularly interesting, especially the first attempts at alternating current transformers, in which this firm was one of the first, if not the very first, to do really useful work.

MR. HEATHER'S PAPER ON THE ELECTRIC TRANSMISSION PLANTS AT MOODIE'S GOLD MINES.

E. K. SCOTT.

THE Institution of Civil Engineers have recently published (see Vol. cxli., p. 269) Mr. H. J. S. Heather's long expected paper on the electric transmission plants at the Moodie's Gold Mine, South Africa.

The information in the paper is particularly interesting, as it gives the actual results of working of two rival systems, viz., *continuous current* at 3,000 to 500 volts, supplied by the late firm of W. T. Goolden & Co., in 1893, and *three-phase* alternating current at 200 to 10,000 to 190 volts supplied by the Allgemeine Elektricitäts Gesellschaft, through Reuert & Lenz, of Johannesburg, in 1896.

The table below gives the leading particulars of the two plants, the chief difference being that the three-phase line is worked at a much higher voltage, and that the continuous current system had a distributing station 4½ miles from the power station, in which were two motor-generators.

System	Continuous current.	Three-phase.
Makers of plant	W. T. Goolden & Co.	Allgemeine Elektricitäts Gesellschaft.
Contract made...	1893.	1896.
Distance of transmission.	4½ miles to distributing station; 5 miles further to Fortuna mine, and 2 miles to Agnes mine, &c.	9½ miles to Fortuna, with branches to Agnes and Ivy extension mines, &c.
Voltage on transmission line.	3,000	10,000
Pelton wheel ...	Two wheels 6 feet diameter, 250 H.P. each, when working on 150 feet fall. Water resistance in connection with Doolittle regulating gear.	
Generators ...	Two rope (separate) driven dynamos in series, each giving 1,500 volts 55 amps. at 500 revolutions.	Four rope (single) driven alternators, each 500 KW. 200 volts, 430 revolutions, 50 ~. The four machines run in parallel.
Exciters ...	Two, each giving 30 amperes, 100 volts.	Four, each giving 50 amperes, 110 volts.
Step-up transformers.	...	Four step-up oil transformers, three-phase, each 100 KW.
Transmission line	Eight wires altogether	Six wires altogether.
Cross arms ...	Iron	Wood.
Step-down at receiving end of line.	Motor-generator, two machines in series, reducing from 2,810 to 625 volts, in a distributing station 4½ miles from power station.	Four step-down (oil) three-phase transformers, each 100 KW., 9,500 to 190 volts. Transformers close to motors, no distributing station.
Motors first set to work.	Ten each of 11 H.P. Goolden type Gramme armatures. Two motors of 45 H.P. of E.C. Co.'s type, with drum armatures. Metallic starting resistances.	Three, each 50 H.P.; two, each 30 H.P., 190 volts, 570 revolutions. Motors insulated from earth. Water resistances.
Types of lightning arresters used.	Keystone	Wurtz, A.E.G., and Siemens & Halske.
Efficiency from generator switchboard to motor pulleys.	About 47 per cent.	About 80 per cent.

The high tension continuous current passed through the motor armatures of these machines in series, while the generator armatures were connected in parallel, and together gave 130 KW. at 625 volts, the power being then divided into five separate circuits. In the case of the three-phase transmission, this distributing station, with its shifts of men, &c., was entirely done away with, the high tension line being in each case taken right up to the motors at the various mines, where ordinary static three-limb transformers reduced the pressure to 190 volts.

The fact that the three-phase installation followed the continuous was no doubt of some advantage in engineering the latter, as it gave an opportunity of rectifying a number of minor details. Thus, in the original plant, each of the generators was driven by five separate ropes, each 1½ inches diameter, and as these worked over a 22-inch diameter pulley, they had to be renewed every six months. In the case of the three-phase machine, on the other hand, a much better relation between the diameter of the rope and the diameter of the pulley was provided, the rope being 1 inch diameter, endless and running over a 13 groove pulley 31½ inches diameter. The makers of the original plant went to some trouble to reduce the number of spares by making the generator and motor of the motor-generator armatures alike, and thus have only one spare armature. As it happened, however, the character and length of the road between the generating and distributing station prohibited the removal of the armature.

The author thinks that the earthing of the generator and motor-generator frames on the old plant was probably a mistake. In putting up the new plant he insulated the transformer frames from earth by about 6 inches of timber. All the motors with the exception of one—the hoist—were on wood, and the main generators were placed on vulcanised fibre ¾ inch thick. It is noteworthy that the only breakdown of a 3-phase transformer from lightning, happened at the hoist, the low tension coils being connected to the only motor having an earthed frame.

The porcelain insulators provided had the inner petticoat dipping into an oil cup. This gives very high insulation, but it was found that under the hot sun the oil was soon dried up, and in the rainy season the rain was liable to splash up from the cross-arm and displace the oil.

The three-phase motor which Mr. Heather found most suitable had slip rings and a water resistance for inserting into the rotor circuit whilst starting up. He mentions that the original continuous current compound-wound motors gave a better starting effort, but as it happened the capability of starting was not of great importance, as almost all the machinery was required to run constantly day and night.

The author's remarks on lightning arresters are extremely interesting, the Barberton district being one in which lightning is very prevalent. Mr. Heather noticed that the telephone insulators broke down during a lightning storm a good deal more frequently than the power insulators, and on investigation, he found that it was due to the thinness of the earthenware between the wire and the insulator bolt, this being only ¼ inch thick on the telephone insulators, as against ⅞ inch on the power insulators. The trouble was overcome by simply leaving the end of the bending wire long enough to be bent down and round until its extremity came to within ⅛ inch of the insulator bolt. After these short spark gaps had been fitted to about every tenth pole, there was hardly any other case of a telephone insulator breaking down. The great value of the Siemens & Halske horned type arrester is pointed out.

Summarised, the most conspicuous advantages of the three-phase transmission were :—

1. The saleable output from a given quantity of water was about doubled, this being mainly due to the increased voltage and the abandonment of the distributing station.

2. The staff and other expenses were reduced nearly one-half, the new plant being run by three white men, two of whom each take six 12-hour shifts per week, and the third man has charge of the station generally and takes the other two shifts to make up the seven days' run.

3. By improved arrestors, running through thunderstorms was rendered possible, resulting in an average gain in running time of over 14 hours per month.

4. The unsatisfactory telephone service was rendered superfluous as far as regards the running of the machines.

5. About 15 tons of copper was saved over that required on the old line.

6. The windings of the three-phase generators and motors seemed to be less liable to breakdown. This was partly due to the windings being carried through slots in the core instead of laid on the surface, as in the original machines. The absence of commutators was also of great advantage.

7. The switching arrangements throughout were extremely simple, more particularly at the motor ends. The

asynchronous motors at 3,500 volts.

very first, to do really useful work.

liquid resistance starter for the three-phase motor proved very convenient.

8. The motor speeds being dependent only on the frequency, remained practically constant, so long as the generators were kept running at a steady pace. The taking off or putting on of any motor had no effect whatever on the speed of any other motor; whereas, on the continuous current system, the taking off of a motor allows the voltage, and therefore the speeds of any other motors on the same circuit to increase.

THE LIMITATIONS OF BLOCK SIGNALLING.

The remarks of Lieut.-Colonel Yorke in a recent report, on the apparent negligence of signalmen in carrying out their duties in strict accordance with the rules of the service, merit more than ordinary attention, backed up as they are by specific instances of cases in which he has conducted inquiries on behalf of the Board of Trade. Railway signalling demands implicit obedience to rules in order to ensure safety, and the developing of the signalling apparatus has ever had in view the imposition of checks upon the operations of, and between, the signalmen concerned. When so responsible an officer calls attention to apparent disregard of regulations which alone render the checks effective, the position seems to be of a very serious character indeed.

"The object of block telegraph signalling is to prevent more than one train being in the section between two block signal cabins on the same line at the same time."

This definition by mentioning only the "telegraph signalling" apparatus would seem to imply that such apparatus constituted the "block." This, of course, is far from being the case. The outdoor mechanical signals, which alone finally control operations on the line, are of the first importance. The definition, moreover, would be more complete if it read, ". . . between two consecutive signal cabins in operation for the time being . . ."

It is, of course, perfectly well known that the "block" is a system of discontinuous section signalling, in which the electrical apparatus is used for making arrangements for the passage of trains, and for notifying and recording as long as necessary their positions on the line from time to time. The outdoor signals, as already stated, control the actual movements of the trains. It is also perfectly well known that both classes of apparatus are operated by the same man for any block post or cabin.

If we consider the grouping of the apparatus under the control of a signalman and the rules under which he must operate it, we are at once struck with the apparent importance given to co-operation between the two signalmen concerned with a section in so far as the electrical apparatus is concerned, and their perfect independence in the operation of the mechanical signals. Without detailing operations which are perfectly well known, the net result may be shown to be that the signalman to whom a train is being despatched is responsible for the entrance of the train, and controls the condition of the section generally, whilst the signalman at the entrance to the section is responsible for detaining it until he has obtained permission for its despatch according to rule. In so far as regards information of the condition of the section from time to time the two men are on an equal footing, since the electrical apparatus exhibit identical indications at both points simultaneously.

Hence we see that checks exist in working the electrical apparatus by which the signalmen exchange information and make arrangements, and record the latter as long as may be necessary. At this point, however, the checks cease. There is no interdependence between the two classes of apparatus employed, and there is, further, no interdependence between either class of apparatus and the trains they control. The checks against error in working the electrical apparatus again are only effective on the assumption that both signalmen are equally cognisant of the exact circumstances obtaining at any time. There is, therefore, no certainty that the apparatus exercising direct control over the movements of trains will be worked in absolute consonance with the apparatus by which the arrangements are mutually made. The signalman at the entrance to a section may, if preoccupied or absent-minded, send a train away without having obtained permission to do so, and, similarly, the signalman at the exit from a section may give the necessary permission for a train to advance without having satisfied himself that the previous train has been fully disposed of. In the first case the mechanical signals are operated improperly and independently of the man most concerned, and in the second case the train is sent away under prohibited conditions because the man controlling its despatch has no means of checking the actual conditions, and must rely implicitly on the information supplied to him by his *confrères*. That the electrical apparatus may be indicating plainly the exact conditions at the time has, in many instances in the past, been found quite insufficient to prevent the blunder. Human beings are all subject to fits of abstraction. In some cases the result provides the funny man with a jest; in other cases the result is a railway accident, which is "no joke."

Rules and regulations may be drawn up to control almost any operation, and the more multitudinous they are the less reliable they become. The drafting of such rules, moreover, recognises the liability of those for whose guidance they are drawn up to go astray, and do that which is not *à propos* to the circumstances of the time. How, otherwise, should rules be necessary? They also imply an instantaneous recognition of the circumstances they regulate, which is not always justifiable, and the history of the development of railway signalling tells of a continual struggle between rules and apparatus, in which the latter alone has justified itself, and the former have been invariably found wanting.

Granted, then, that human nature is fallible, and that the provision of the most elaborate rules has not entirely banished the possibility of serious results from momentary lapses, in what direction should checks be imposed? Should it be in the preliminary arrangements between two equally fallible persons, as at present? or should it be in the direct execution of the arrangements arrived at jointly, and with especial regard to the order and continuity of the operations to be performed? That checks which act directly in the manner indicated are available, and in use to a small extent, is well known. That the cost of installing such apparatus in place of that now in use or of adapting the latter, will be great, is true. *The* question, of course, is, "Are the results likely to justify the expense?"

NEW FORM OF CALORIMETER.

In his paper to the British Association Prof. Goodman described a new calorimeter, consisting of two vessels on one end of a balance, which will turn with $\frac{1}{100}$ lb. in 120 lbs. From one vessel he draws water at a certain fixed temperature, and injects it by means of the steam to be measured into the other vessel. The mixed stream passes a thermometer, and this is read every 10 or 15 seconds. The final difference in total weight is the weight of the wet steam added. The alteration of the weight of the two vessels shows the addition or abstraction of their contents. If the water used is represented by W, and the added steam by s; the dryness fraction of this steam by x; if L stands for latent heat of steam; t its temperature; t_2 the mean temperature of the mixed stream; t_1 that of the original unmixed water,

$$x = \frac{\frac{W}{s}(t_2 - t_1) + t_2 - t}{L}.$$

The errors are claimed not to exceed at most 1 per cent. in the quality of the steam, but the author evidently has grave doubts of the possibility of securing a fair sample of steam, and here we agree with him. We do not believe there is in existence a reliable means of taking even approximately accurate steam samples. Bent pipes, perforated pipes, salt tests, and all the rest of the devices employed for this purpose are useless. The author also condemns that much-praised instrument, the throttling calorimeter, for he denies that the specific heat of superheated steam is invariable. Mr. Grindley, of Manchester, says it varies from 0·4 to 0·68, instead of being constant at 0·48,

as until lately assumed. But we are not told at what temperature the specific heat varies in this manner. We do not believe it varies at a given temperature from the same figure, but Prof. Goodman is lax in his paper, and does not define his objection. He does, however, plainly state that Continental engine makers have obtained their reputation by stating that they only guarantee steam engines on an equivalent consumption of dry steam, and that reduced to this basis British makers would show as well. Often steam reaches an engine much wetter than 2 or 3 per cent. He also points out how certain boilers have been claimed to be economical purely on the basis of the amount of water passed through them, ostensibly as steam, really as hot water and steam. We confess to having very little faith in published records of evaporation and steam dryness tests, and we think they ought to be put on to a firm basis by means of superheating. It is bad practice to-day to attempt to use steam that has not a considerable degree of superheat.

CURRENT SPECIFICATIONS.

XXXI.—ABERDEEN TRAMWAY EXTENSIONS.

SUMMARY.

Scope of Contract.—Supply of 25 completely equipped electric tramcars, and conversion of six horse cars for electric work.

Type of Car.—Double-deck, to seat 52 passengers, 24 inside and 28 outside.

Gauge of Line.—4 feet 8½ inches.

Type of Truck.—Four-wheel non-pivotal type, with 6 feet wheel base, and fitted with 30-inch diameter wheels, guaranteed to run 20,000 car miles without requiring renewal.

Type of Life Guard.—Wilson & Bennett's patent life guard to be provided for in tender.

Type of Motor.—Two 25-H.P. motors, ordinary traction, series-wound, ironclad type.

Gearing and Speed.—Motors to be geared to 30-inch wheels through single reduction gearing, having a ratio not more than 4·8 to 1. Motor to be able to drive a fully loaded car at rate of 8 to 10 miles per hour.

Type of Controller.—To be of series-parallel type, with rheostatic brake arrangement.

Systems of Brakes Specified.—Each car to be fitted with hand brakes, rheostatic brakes, and Newell's patent electro-magnetic track brake.

Type of Trolley.—To be of latest design pivotal type.

Heaters.—Four fireproof electric car heaters to be provided and fixed.

Electric Equipments for Existing Cars.—Material to be delivered at car sheds, Aberdeen, where the parts will be fitted by the servants of the Corporation.

Specified Date of Completion.—Tenderers to state how soon they can deliver 12 complete new cars, and six equipments for existing horse cars.

Penalty for Late Completion.—£25 per week.

Stipulation as to Removal of Foremen.—Satisfactory.

Stipulation as to Wages paid to Workmen.—Satisfactory, see comments below.

Arbitration Clause.—Novel in some respects, see comments below.

Terms of Payment.—75 per cent. on engineer's certificates during construction, 12½ per cent. on completion, and balance of 12½ per cent. at end of 12 months period of maintenance.

Date for Receipt of Tenders.—October 17th, 1900.

We have here another instance of a borough electrical engineer acting as consulting engineer to the tramway undertaking. This is not the first instalment of traction plant, as one section of electrically equipped tramways is already running. There is little special about the technical portion of the specifications except the ample provision made for brakes, each car being fitted with no less than three types, hand, rheostatic and Newell's patent electro-magnetic.

It is stipulated that the successful tenderer must be able to point to installations in this country where his apparatus is in actual use, obtaining for the engineer permission to visit the towns named in order to examine the behaviour of the motors and cars in everyday working.

Taken as a whole the general conditions are of a fair character, and may be accepted by a contractor without fear.

There is a 12 months' period of maintenance against defective workmanship and material, power reserved to the engineer to vary the work after agreement with the contractor as to alteration in contract price, and a stipulation that—

> The successful contractor shall be bound to pay the workmen employed by him not less than the standard rate of wages relating to the particular trade to which this specification applies.

The one clause in the general conditions which calls for special mention relates to the appeal to arbitration. In place of the engineer or any employé of the Corporation being designated as arbitrator, provision is made for the submission of all disputes to the decision of the city electrical engineer of Glasgow for the time being. This is a practice which may well be followed, though whether it is politic to add such duties to the already overworked electrical engineers of our large provincial towns, is a question which ought to be carefully considered.

The wording of the clause is the reverse of concise, but it meets all reasonable requirements, and as a curiosity in the art of saying a little in many words, we reprint it here :—

> If at any time before the commencement, or during the progress, or during the period of maintenance, of the works, or after the completion of the contract, any disputes or differences shall arise between the Town Council and the contractor, or between the Town Council and his representatives or parties claiming in his right as to the true intent, construction, or meaning of this specification, or of the said drawings, or of the tender by the contractor, or acceptance thereof, or of any of the conditions contained in each or all of these, or of anything to be contained in the formal contract to be entered into as hereinbefore provided, or as to the terms in which such contract shall be framed, or as to the manner of executing, or protecting, or maintaining the works contracted for, or as to the quality of the materials employed, or proposed to be employed therein, or as to the measurement or valuation of the works executed under the contract, or the amount of any advances to be made to the contractor, or as to any claims for additional or extra works, or as to any claims of deduction for, or in respect of, alterations or diminutions on the works, or as to any charge, account, cost, expenses, or damages made or claimed by the Town Council against or from the contractor or his foresaids or sureties, or made or claimed by the contractor or his foresaids against or from the Town Council, arising out of the execution, or the failure in the execution of the works or any part thereof, or arising out of, or payable by reason of, the performance or the failure in the performance of any of the obligations undertaken by the parties in the contract, and generally as to the rights or obligation of either party under this contract, or any matter or thing, whether of the nature above specified, or of any other kind, as well non-executorial as executorial, arising out of, or in any way connected with, the execution of, or failure to execute, the works contracted for, or the performance of, or failure to perform, any of the obligations undertaken by the parties, or the exercise of any of the powers conferred on them, or arising out of or in any way connected with the contract, then *all such disputes and differences shall be submitted and referred to the decision, final sentence, and decreet arbitral of William Ashcombe Chamen, M.I.E.E., electrical engineer to the Town Council of Glasgow,* whom failing of the engineer for the time being, and *whatever the said arbiter shall determine in the premises in whole or in part, by award or awards, decreet or decrees, arbitral whether interim or final,* the *Town Council and the contractor,* and their respective foresaids, *shall be bound to acquiesce in, implement and fulfil to each other ;* which submission shall not fall by the lapse of year and day, nor by the death or bankruptcy of the contractor and his foresaids; and it is specially declared that the said arbiter shall have full power under the said submission not only to determine the liability of any of the parties to the other for or in respect of the claims, charges, accounts, costs, expenses, or damages, as to which any dispute or difference is referred ; *but also conclusively to assess and fix the amount of such claims, charges, accounts, costs, expenses, or damages ;* and the said arbiter shall also have power to award the costs, either in whole or in part, which may be incurred under the said submission (including the expenses and fees of the arbiter and clerk), and of making out, recording, and extracting the award or awards decreet or decreets arbitral, to follow thereon, against such of the parties as he shall think fit.
>
> *The arbiter acting for the time shall have power to proceed, in the reference made to him, on the request of either party communicated to him in writing,* and to take such steps as he shall think necessary for enabling him to decide on the matters submitted to him, and that in such form and manner as he shall think proper. Clauses or obligations of submission shall be inserted in the formal contract in such terms as shall give full effect to the said submission, and make the same operative, and containing the said obligation on the parties respectively to abide by, and implement, and fulfil, whatever the arbiter shall determine in the premises, and *the said submission shall be held to exclude the jurisdiction of any court of law in reference to any of the matters before referred to.*
>
> Nothing contained in the said submission shall be held as derogating from, abridging, or restricting the rights or powers conferred on the Town Council or the engineer by the specification and conditions contained in them and each of them, or be construed to prevent full effect being given to the opinion or judgment of the engineer in any case in which it is thereby provided that any matter or thing shall be determined by, or be dependent on, such opinion or judgment.

We trust that this practice of submitting disputes to an independent authority will become general ; it is a much needed reform, and one which should commend itself to the judgment of all concerned, consultants as well as contractors.

INCREASE IN THE USE OF GUTTA-PERCHA IN ELECTRIC CABLE BUILDING.*

By HAWTHORNE HILL.

To gutta-percha has been devoted of late a measure of attention which, perhaps, has not been equalled since this material first became known to commerce, and was seized upon by manufacturers as a possible substitute for india-rubber, the use of which at the time was monopolised under the patents of Goodyear in America and Hancock in England. The test of time proved the new material to be unsuited for the more important uses to which india-rubber has been put, however, and with the expiration of the patents referred to, the use of gutta-percha became confined more and more to that purpose for which it long has been deemed the material *par excellence* —the insulation of submarine telegraph cables. It is on account of a wide-spread demand for more cables that so much attention is directed just now to gutta-percha, and particularly to the question whether existing supplies are equal to current and prospective requirements. The governments of many countries and merchants and the press everywhere are becoming alive to the desirability of additional means for speedy communication across seas.

From the political and military necessity for means of close communication with India, when to Victoria's title of Queen was added that of Empress, grew that degree of interest in ocean telegraphy in England which at once placed that country in a position of undisputed prominence in the cable industry. There was then no German Empire; France had no African possessions comparable in importance with what she now owns; the United States had never heard of the Philippines; and the outside world would as soon have thought of cabling to the Milky Way as to China. But now every first-class power has some such reasons for building cables as led England to establish her first line to India, and the merchants and manufacturers of every land want cable facilities not controlled by foreign powers, just as it is thought to be the thing to conduct the foreign shipping trade of a country under its own flag.

The extent to which submarine cables are being planned is suggested by a list of proposed new lines, compiled by Karl Supf, in the *Deutsche Kolonialzeitung*, of Berlin, aggregating 66,176 nautical miles. The purport of these figures is indicated by comparing them with the total length of the ocean cables in operation at the beginning of 1900, namely, 177,989 miles, this being the result of more than 40 years of active construction. Herr Supf regards as necessary for the construction of the new cables—allowing 80 kilogrammes of gutta-percha per kilometre, or 283·84 lbs. per mile—no less than 18,791,254 lbs. of the insulating material. It is hardly worth while to follow out Herr Supf's calculations with regard to cost, since prices are variable; the question of real concern is whether so much gutta-percha is obtainable in the near future, or is even in existence. The estimate per mile, by the way, is not excessive. The average weight of gutta-percha used on the 41,853 nautical miles of cables laid in the North Atlantic Ocean from 1856 to 1896, including many short lines, requiring only light insulation, was, according to Dr. Obach, 289 lbs. per mile. But for the cable laid by the Anglo-American Telegraph Company, in 1894, the weight of gutta-percha per nautical mile was 400 lbs., and in the Brest-New York cable, laid in 1898, the weight was about 396 lbs. But Herr Supf has overlooked the important detail of the loss of weight in preparing raw gutta-percha for use. Taking Dr. Obach's estimate of loss in wasting—33⅓ per cent.—instead of the requirements stated by the Berlin writer, there would be needed 28,186,881 lbs., or 12,785 metric tons, of commercial gutta-percha. Considering that during the history of the gutta-percha trade (1844-1899) less than eight times this amount of gutta-percha has been produced, and also that a considerable part of the yearly product is not fitted for cable work, it would appear that such large requirements are not likely to be met very soon.

Yet it does not follow that there is reason for alarm. We may wait for convincing evidence that France, for example, is to give effect to the suggestions of the Government commission appointed lately to report upon a system of cable communication with the French colonies in Africa and the Far East, for political and commercial reasons. The elaborate plan of the commission calls ultimately for 15,760 nautical miles of cable, at an estimated cost of 130,000,000 francs, though only 9,245 miles are recommended for immediate construction. But the French programme provides for the building of the cables by French works and their laying by French ships, and the existing facilities in that country are inadequate for such an undertaking; besides, no credit for cable extension appears in the French budget for 1901, even. Evidently, therefore, the French requirement for gutta-percha is not pressing. Herr Supf has France down for 30,000 kilometres (18,641 miles), or nearly 3,000 miles more than the French commission's estimate.

Some 31,000 kilometres of projected cables are credited to England (1) for the new cables from the mother country to Cape Colony, and thence to Australia, which have already been contracted for, and (2) for the long-talked-of Pacific cable, new tenders for which have been invited of late. The gutta-percha needed for the first undertaking is already provided for; it is not impossible that the completion of the system may block the way for some years for the second project. The Eastern Telegraph Company, Limited, and the allied companies regard with no friendly eye the prospective competition of a line across the Pacific, and who can say that their recent alacrity in supplying England with additional cable connections to her colonies, without subsidies, and in reducing cable rates very materially, has not been meant to discourage the Pacific cable project? The investments of the Eastern and allied companies in new cable enterprises during the past fiscal year, and in immediate prospect, aggregate $18,710,000, including the cost of the lines to Australia *vid* South Africa above referred to. The Berlin statistician can mark off his list, therefore, all that he has set down for England except the Pacific cable, and that doubtless will wait until very much more gutta-percha has been brought to market.

With regard to a United States cable across the Pacific, while the prospect is not very definite, it probably is as much so as the new German colonial cable projects which are put down in the Berlin estimate for an equal or greater mileage. The remainder of the estimate is made up of comparatively trivial items.

However emphatic the demands for new cables from so many quarters, probably the actual construction in the near future will not be at a greater rate than for some years past. The total length of submarine cables in operation at the following dates has been, in nautical miles:—

At the beginning of 1896	161,578
At the beginning of 1898	167,678
At the beginning of 1900	177,988

At this rate of growth, while the prices of the better grades of gutta-percha have advanced, they have not done so to such an extent as to cause capitalists or cable manufacturers to hesitate to consider any new projects having apparent merit. At present probably 3,000,000 lbs. of raw gutta-percha are required annually for cable purposes, and there is as yet no reason to fear that this rate of production of good gutta-percha cannot be maintained.

Exports of Gutta from Singapore.

In Pounds.

1889	6,606,720
1890	9,535,680
1891	7,013,440
1892	4,258,240
1893	5,066,880
1894	6,229,467
1895	6,251,200
1896	6,250,000
1897	6,437,733
1898	10,185,333
1899	16,178,133

No one knows how much gutta-percha is still available in the East Indian forests. The years when the consumption in Europe has been large have been marked by heavy exports from Singapore; when the building of cables has been slack the output of raw material has fallen off, indicating that it has only been necessary for a real demand to exist for the work of collection to be stimulated. During the past three years the exports of gutta-percha from Singapore have been unprecedently large, and this fact, rather than any actual scarcity in the markets, has given rise to a fear of the extinction of the gutta-percha species. Unlike the rubber trees of Brazil, which may be tapped from year to year for half a century, the gutta-percha trees are cut only once—when they are cut off at the roots. Hence, unless the supply of trees is enormous, or young trees are maturing as fast as the old ones are destroyed, there may come a time when no more can be found. Already districts once important for their yield of gutta-percha have become exhausted, and the length of time required for new trees to mature discourages the formation of private plantations, while no important governmental attempts at cultivation have been made.

A great problem is what Borneo may have in store. Wherever this immense island has been explored, gutta-percha has been found. Concerning the district of 31,000 square miles controlled by the British North Borneo Company, a recent report says that they "have only touched the fringe of the country, the interior is yet unknown." The same might be said of Sarawak and Brunei, also under British influence, with a combined area of 50,000 square miles. Dutch Borneo has been developed still less. Altogether this island has an area of 183,000,000 acres, mostly covered by forests. Allowing one gutta-percha tree to an acre, with an average yield of 8 lbs. per tree, the yield would be over 660,000 metric tons of gutta-percha. These are impossible figures, of course, but one might as well fear the early total exhaustion of coal because a single mine has been worked out, as be alarmed at the destruction of the trees on the mere fringe of a jungle-covered island larger than New England, the Middle States, Maryland, and the two Virginias. Besides, there are other islands—Sumatra and Java, particularly—and the Malay States.

But if there should be a falling off in the gutta-percha supply, india-rubber remains as an insulating material from which favourable results have been obtained on not a few short lines of cables. Even if electricians and capitalists should hesitate to adopt this material for long cable spans, it may be pointed out that a very important part of the world's cable system is made up of short lines. Of the cables in operation at the beginning of 1900, there were 1,334 owned by Governments, of an average length of only 15·25 nautical miles, and 408 owned by private companies, of an average length of 386·35 miles. Two years ago there were in existence only 38 cable lines over 1,000 miles each in length, and their aggregate, 61,200 miles, formed only 36·63 per cent. of all the cables in operation. Much of the cable construction in prospect is to be in short lengths, and in case there should be a gutta-percha famine it is likely that india-rubber would be used for these, leaving the more thoroughly tested dielectric for such lengths as are required for crossing the Pacific. This is not written, by the way, in prejudice of the use of india-rubber under any or all circumstances.

The growing demand for golf balls has led to exaggerated

* New York *Electrical Review*.

to the particular trade to which this specification applies.

tractors.

accounts of the consumption of gutta-percha in their manufacture. Newspaper accounts have placed this consumption at millions of dollars for the United States alone, but thus far most of the golf balls used in this country have been imported, and the largest imports of gutta-percha goods of all kinds in any one year have been officially reported at $254,332 in value. The value of the raw gutta-percha imported in the same year was only $178,616, making a total of $432,948 for gutta-percha in all forms, for golf and for other uses. Taking the world as a whole, perhaps the increasing manufacture of golf balls has been offset by the declining use of gutta-percha for other purposes, as this material gradually has become more expensive.

OUR LEGAL QUERY COLUMN.

[*Questions addressed to the Editors for insertion in this column should be as brief and concise as possible. Free use of fictitious names, &c., may be made. Answers are furnished by a duly qualified lawyer, but the Editors cannot undertake to be responsible for the accuracy of the views which he may express.*]

"F. J. H." writes:—"I shall be extremely obliged if you will kindly reply to the following:—A man holds an agency in a certain town for electrical plant manufactured by a London firm. Commission is, of course, due to him on all orders he actually obtains, but in the event of an order being received by the London firm from an external source to deliver goods in the agent's district, is the agent entitled to any commission on those goods (the firm ordering the goods not being in the agent's district).

"(2) If there is another contractor residing in the agent's district who requires some of the London firm's goods, but who refuses to deal with the agent for some reason, and insists on doing business with the London firm direct, is the agent legally entitled to commission on goods ordered by that contractor direct from London, and is any difference made in the case whether the goods are delivered in the agent's district or not.

"(3) Is the agent legally entitled to commission on goods delivered outside his district, although he received the order for the same, the party ordering not being of necessity in his district."

*** The questions put by our correspondent involve some careful study of the law of agency. In stating his test cases he has omitted to mention the *terms* upon which the agency in question was undertaken. Agency, as need hardly be pointed out, is founded upon contract, be the same verbal or in writing, and to ascertain the respective rights and liabilities of principal and agent, the terms of the document, or the words used when the contract was entered into must be closely examined.

Assuming, however, that "F. J. H." refers to a "sole agent" within a particular area, and that the ordinary principles of law are unaffected by the contract into which his imaginary agent has entered, he may find the following observations of some value. The "sole agency" of a district involves the right to claim commission on all articles of manufacture of the principal sold within that district. Thus, suppose a person residing in the district ordered goods direct from the London firm. The first duty of the London firm would be to write and inform their accredited agent of the fact, and pay him commission, if required, the theory being that he has advertised in the district, that his advertisements have given rise to the order, and that he is entitled to reward for his services. Assuming, however, as in the first case put by our correspondent, the firm giving the order resides outside the district, different considerations arise—for then no part of the contract, except the delivery of the goods, would take place in the district. To put the matter in a nutshell, the words sole agency imply "that commission will be payable to the agent on all orders for our goods given by persons residing in and executed within the said district." For these reasons we are of opinion that, in the absence of special terms, the agent could make no successful claim for commission in Case 1.

With regard to question (2), if the foregoing interpretation of the term "sole agency" is correct, it seems that the question whether the customer will or will not deal with the agent is irrelevant. When the order is given and the goods are delivered within the district, natural consequences follow; and, wholly apart from the proper interpretation of the words "sole agency," we anticipate that the refusal of the customer to deal with the agent does not affect the contract between principal and agent. In support of this, we might mention that it has been decided that where a doctor sells his practice, and undertakes to see no more patients in the district of which he has sold the good-will, he commits a breach of contract by attending a patient who earnestly solicits his attendance and flatly refuses to consult the new practitioner.

If we adhere to the interpretation we have already placed upon the term "sole agency," we must answer question 3 by saying that in such a case the agent would not be entitled to commission. Nevertheless it is clear that an exception must be made to meet this case, as the agent must obviously be rewarded for every order he obtains.

The foregoing observations will serve to show how important it is that the rights and liabilities of an agent should be clearly defined in his contract. Should "F. J. H." meet with any further difficulty, he had better lay his case before a solicitor.

MEASUREMENT OF THE RESISTANCE OF CABLES.

By ARTHUR C. HEAP.

To conform to the requirements of recent specifications for electric light cables, it has become necessary for manufacturers to provide themselves with instruments which shall be capable of measuring the resistance not only of the samples of copper of which the cable is made, but also of the finished cable.

The measurement of the resistance of samples where the copper is drawn into wire of suitable section, and where any desired length may be taken, can easily be done on the

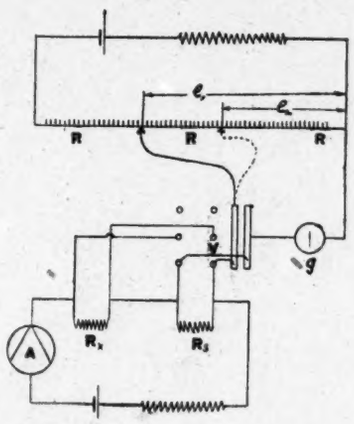


Fig. 1.

Wheatstone bridge: but when the resistances of short lengths of large section cable have to be measured, it is necessary to resort to one of the difference of potential methods. At the same time the instruments used must be accurate, direct reading, and quickly handled, and the connections must be such that they can easily be followed by the

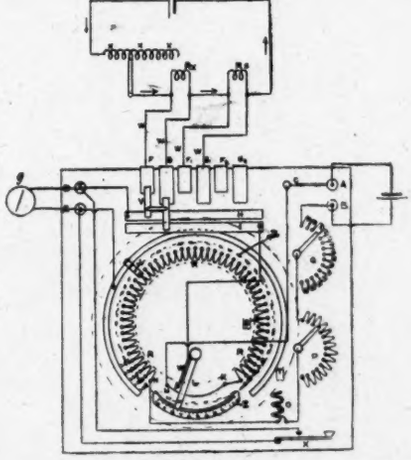


Fig. 2.

consulting engineer or his assistant, who may not be familiar with the particular test room in which he is working. Of these potential methods, the simplest is probably that in which the direct-reading potentiometer is used.

In England the low resistance potentiometer is, on account of its greater rapidity of working, almost universally employed.

The test consists in balancing the fall of potential produced by a current passing in a suitable length *l*, (fig. 1) of a slide wire, R, R, R, whose resistance per unit length has been accurately adjusted, against the fall of potential over a standard resistance, R_s, of suitable value, the unknown resistance, R_x, and the standard, R_s, being connected in series in a

circuit in which a constant current is maintained; the fall of potential over the unknown resistance is then, by moving the switch, V, substituted for that over the standard, and the position, l_2, at which balance is obtained on the slide wire noted. The resistances are then directly proportional to the lengths, l_1 and l_2, of slide wire employed; that is,

$$R_x = R_s \times \frac{l_2}{l_1}.$$

The instruments necessary are, therefore, a potentiometer, in which the adjusted slide wire is conveniently arranged, a set of standard resistances, a sensitive low resistance D'Arsonval

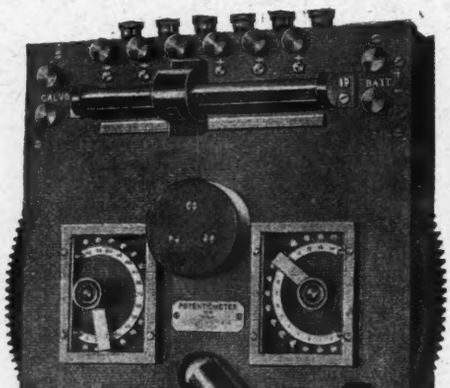


Fig. 3.

galvanometer, a secondary cell for maintaining a constant current in the slide wire, another for maintaining a constant current in the standard resistance circuit, a regulating resistance and ammeter for this circuit. Fig. 1 is a diagram illustrating the method; figs. 2, 3, 4, a particular form of potentiometer and standard resistance brought out by Messrs. Elliott Bros. In figs. 1 and 2, R, R, R, is the adjusted slide wire, which is about 450 inches long, having a resistance of about 35^{ω}, divided into 150 parts each of approximately 3 inches, by having small copper tags silver soldered to the wire; 149 of these are fixed by means of screws passing through holes in the ends of the copper tags to an ebonite ring, S, as shown; a second ebonite ring, T, carrying a contact tongue, J, turns concentrically round the first ring on balls running in a ball race, U, cut between the two rings. This tongue, J, as it moves round makes contact on the heads of the screws fixing the slide wire; the outer ring, T, is engraved with figures from 0—149 in such a manner that as they appear at a window, seen in fig. 3, they indicate the number of the stud on which the tongue, J, is making contact. The 150th portion appears on the top of the instrument at MK, and is the portion on which the key, W, attached to the lever, L, makes contact; this lever travels over a graduated scale, Z, which indicates the position of the key.

The manufacturer's adjustment consists in making each of the 150 portions of the slide wire accurately equal to one another, and in calibrating the scale over which the key travels. O, P, Q, are resistances in series with the slide wire, R, R, R, and have no accurate ohmic values, but are such that O being the slow adjustment of approximately 1 ohm, the resistance between each two studs of P is about 0·95 ohm, and the resistance between each stud of Q is about 13·25 ohms, that is, they are overlapping rheostats, having a total resistance of about 188^{ω}; G is a delicate d'Arsonval galvanometer, having a resistance of about 50 ohms; V is a multiple switch, having contacts F, G, F_1, G_1, &c., by means of which six different quantities can be compared; C is a fuse to protect the slide wire, and X is a shunt key to reduce the sensibility of the galvanometer.

As the range of resistances to be measured is wide, varying from 0·2 ohm for samples down to ·00528 ohm, which is approximately the resistance of $\frac{1}{8}$ mile of 1 inch core cable, and even as low as ·000025 for traction rail bonds, several standard resistances are required.

It is usual to supply:—

1	ohm standard to carry	1·0 amperes.
$\frac{1}{10}$	" "	10·0 "
$\frac{1}{100}$	" "	50·0 "
$\frac{1}{1000}$	" "	500·0 "

These resistances are mounted behind a switchboard, on the front of which there is a multiple contact switch, potential terminals, and ammeter complete, as shown in fig. 4, and are connected up so that either standard can easily be put in circuit. In some cases two extra brushes are fixed on the main switch arm, but insulated from it, and these touch on studs corresponding to the potential terminals of the resistances, so that when the main switch is turned to a particular standard, the potential circuit is made at the same time, thus avoiding any moving of the potential leads, rendering mistakes impossible, and increasing the speed at which tests can be made. Some manufacturers prefer to have these standards made of copper and then to neglect all temperature corrections, but it is better to have manganin or other alloy standards with a negligible temperature coefficient, and this for two reasons, first, because copper standards are very difficult to obtain accurate, and secondly, because the cable is usually in a tank at some distance from the standards, and therefore difference of temperature has to be allowed for.

To make a test, connect up the instruments as in fig. 2, select the standard whose value is nearest to that of the wire or cable to be measured, regulate the current by the ammeter in the standard circuit to the required amount, set the switch, V, so that it makes contact on the studs corresponding to the terminals, F, G, to which the potential wires, W W, from the standard resistance, R_s, are connected, set the wheel, T, of the potentiometer so that a convenient figure, say, 100, appears at the window, the key, W L, being at zero; obtain balance (no deflection of galvanometer when key is depressed) by varying the resistances, O, P, Q; now move the switch, V, on to contacts corresponding to W W, the potential wires from the cable R_x, and move the wheel, T, and key, W L, until no current passes in the galvanometer;

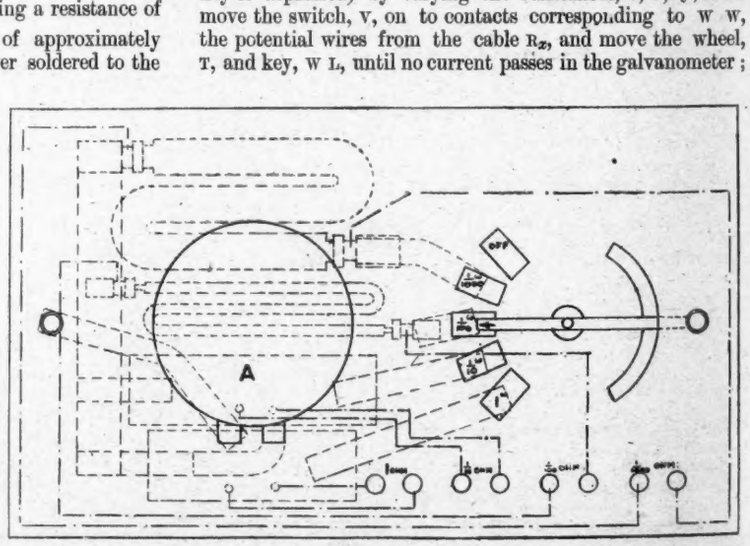


Fig. 4.

reading off the position of the wheel, T, at the window and of the key, W L, on the engraved scale, the resistances are proportional to these two positions of balance. Thus supposing the 1 ohm standard to be in circuit and we balanced at 100 in the window and key at zero, and on turning the switch over to

the unknown we obtained balance by setting the wheel to 40 and the key to 125, then the unknown resistance would be $\frac{40{\cdot}125}{100} \times .1 = {\cdot}40125$ ohm, that is, the instrument would read direct if we read the figures straight from the wheel to the scale, thus ·40125, the decimal place being seen at a glance.

Reference is made above to obtaining a balance by varying the resistance O, P, Q, until there is no deflection of the galvanometer; it is well to set these resistances approximately before putting down the galvanometer key, and thus avoid any banging over of the galvanometer coil and consequent disturbance of its zero.

These resistances may be calculated from the following formula:—

$$\underset{\text{(Approx.)}}{O + P + Q} = \frac{E \times R \times l_1}{R_s \times I \times l} - R$$

Where E = E.M.F. of the battery on the potentiometer,
R_s = resistance of the standard in circuit,
I = current in R_s,
R = resistance of slide wire,
l_1 = position in scale divisions at which balance is wanted,
l = total length in scale division of slide wire.

The question often arises as to what current must be put through the standard resistances, so that accurate readings may be obtained without any fear of the cable being heated, and it is often stated that large currents have to be used in connection with potentiometer measurements. This is not the case, for rarely, except in the measurement of bond resistances, need a current exceeding 50 amperes to the square inch of copper be employed, and where, as is usual with cable makers, lengths of not less than one-eighth of a mile are being measured, 10 amperes per square inch is ample.

For the measurement of the resistance of samples of copper wire a special board is provided, on which are mounted suitable current leading-in clamps for various sizes of wire, and knife edges at a definite distance apart, either 100 inches or 1 metre, according to the standard with which the sample is to be compared, the knife edges acting as potential points; after the measurement of resistance a cutting knife is drawn over, and the wire nipped at exactly the 100 inches or 1 metre, as required, this length being weighed in the usual manner.

The chief advantages gained in using the above instruments are:—

The resistances of the potential wires between the cable standard and potentiometer do not come into the test, since when balance is obtained no current passes in the potential circuits; the cables can, therefore, be at some distance from the test house without any correction having to be made for connecting leads. The resistance is read direct in ohms, no calculation being necessary. Only four standard resistances are necessary to cover a very wide range of measurement; a six-dial Wheatstone bridge would have 68.

The potentiometer slide wire, except for a length of about 3 inches, is placed inside the containing box, and therefore cannot get damaged, and as it is fixed on the under surface of the ebonite top, dust does not collect on the rubbing contacts.

The secret of successful potentiometer measurements is undoubtedly to keep the secondary cells in good working order.

CORRESPONDENCE.

The Bradford Dust Destructors.

I have just had my attention drawn to Mr. De Segundo's article in your issue of September 21st, in which he refers to the paper I read at the recent meeting of the British Association in Bradford.

Mr. De Segundo points out that I have omitted to state the average percentage of moisture contained in our refuse.

This we find from a number of tests is from 35 to 40 per cent., the latter figure often being exceeded during the summer months, when householders are using less coal than in the winter months.

As stated in my paper, the total number of ashpits in the City of Bradford is 32,164. Of these a total of 22,390 are wet ashpits, or privy middens, and only 9,774 are dry ashpits.

The ashpits in the district from which the refuse is collected to supply the Hammerton Street destructor are nearly all wet ashpits, the proportion of dry ashpits being very small indeed, and it should be distinctly understood that the whole of the contents of these wet ashpits is dealt with by the destructor.

During the last six months, 60,340 loads of ashpit refuse have been collected, and of this, we have only been able to dispose of 1,449 loads for manure.

Mr. De Segundo's suggestion of a quarterly test is one which I shall endeavour to carry out at an early date.

John McTaggart.

Bradford, *September 27th*, 1900.

Wireless Telephony at Sea.

The report of Sir W. H. Preece's B.A. Address to Section G in the Electrical Review of September 21st, 1900, is illustrated by a diagram and a sketch descriptive of a method of telephonic communication between ships at sea, the circuit being formed by a copper wire passing over the mastheads, and terminating at each end of the ship in copper plates immersed in the sea.

Instead of trailing these plates in the sea, it would appear feasible that the copper wire might be, in the case of a wooden vessel, soldered on to a copper plate insulated from the metal sheathing of the bottom, and in the case of an iron vessel, to a copper plate insulated from the plating of the vessel itself.

Coast Communication.

London, *September*, 1900.

Meter Systems.

Being questioned by clients upon this subject, I am anxious to be able to give a definite and concise reply.

Would any of your readers, for the benefit of the many, care to tabulate the accruing results in cost per 8, 16, and 32-c.p. lamp per hour, of the many and varied systems of metering the energy consumed throughout the kingdom? I am sure such a table would be much appreciated.

Percy E. White.

Victoria Street, S.W.

Gas v. Electric Driving.

"Inquirer" wishes to ask whether any readers of the Electrical Review can offer information on the comparative cost of running a saw mill by gas engine, or by power from continuous current, 400-volt supply mains.

Which would be the cheaper, and which the better? At the moment, a 50-h.p. (nom.) steam engine satisfactorily executes all requirements. Allow the limit of brake horse-power to be 75 on the steam engine.

Annealing Stampings.

Can any reader give the name and address of makers of furnaces, such as are used for annealing armature and transformer stampings; or particulars of the construction, mode of heating, temperature and time required in process? Considerable quantites are intended to be dealt with.

A.M.I.C.E.

E

Interior Wiring.

I read with great interest the article on "Interior Wiring" in your last issue, and I would ask your kind permission to make a few remarks thereon.

In the first place, I would point out that the very frequent use of the "personal pronoun" will lead many readers to believe that the ideas enunciated therein are Mr. Allingham's own. I have written to him and he claims that the idea of "intermittent earthing" at least is entirely original.

Taking this point first, Mr. Allingham must suffer from a lamentable lack of memory, for both he and I saw this "earthing" carried out by the engineer to the Leyton Council some three years ago with, I believe, rather disastrous results. On the occasion in question the engineer noticed an earth on one of the mains (as shown by the earth lamps), and proceeded to successively earth the mains to cut off the offending consumer. As might be expected, the result was that one side of the system developed a short of rather persistent character, the system was thrown out of balance, and all the lamps in use on the other side were burnt out. This earthing idea is very good if the engineer can be sure that the earth is not on the station side of the consumer's main fuse, and if there is no main fuse which will carry any considerable current. It is, however, impossible to tell whether an "earth" is on the mains or the consumer's premises.

Mr. Allingham's "idea" was therefore neither original nor practicable in anything like a general manner.

In the second place, I feel that it is only fair to me, as the other partner in the late firm of Allingham & Fennell, to state that Mr. Allingham has no right to monopolise the credit (if any) of the experience of that firm, as he does throughout the article. In a scientific partnership it is usually recognised that the work of the members cannot be distinguished, especially when, as in this case, both members were engineers, and were constantly discussing and suggesting improvements.

W. Fennell.

Prof. Thompson's Lecture at Bradford.

Last week I put into simple and definite shape three of the allegations or insinuations contained in your editorial article on p. 447, and asked you to say plainly whether that was what you intended your readers to understand to be asserted. The shuffling replies you have thought fit to make, compel me to place the facts before your readers.

1. You informed them that something I said "seemed not only quite uncalled for, but likely to give a wrong impression." "The overhead trolley was not much in evidence amongst the Professor's lantern pictures, *if it was shown at all*" (these italics are mine). The fact is, that I showed *six* lantern pictures relating to electric traction, and *in five of these there were overhead trolley-lines*, while *one* only was shown without them. And yet you think it fair and decent to give your readers the insinuation in the words "*if it was shown at all!*"

2. You stated—and the italics in this case were your own—that I advocated doing things "so that they could run through to all the other towns in Yorkshire and *without any overhead wires*." I asked you last week whether you intended your readers to suppose that that was what I advocated. Your shuffling reply shows that you know you have misrepresented me. You suppressed essential words from the sentence, which is correctly reported in the *Bradford Observer* of September 10th, as follows :—

"The cars should be all electrical, of the proper gauge, that they could be run through to all other towns in Yorkshire without change and also without overhead wires, *at any rate in the centre of the city*." (I have here put into italics the words you have suppressed).

3. Not content with garbling my words and misrepresenting my views, you have charged me with posing as the sole inventor of all surface contact methods. I have challenged you as to whether that is what you wanted your readers to understand; and again you shirk giving a plain or straightforward answer. Let me state exactly what I did say. I was speaking of the various methods of traction in which overhead wires were dispensed with, including surface contact methods. At that moment there was on the screen a photograph of the surface contact car on the experimental Thompson-Walker line at Willesden. Pointing to it, I said, "There are several different ways of doing this: *that's mine*." On those two words you build up a reckless charge of ignoring all other ways of doing the same thing; and you wind up with the gratuitous insinuation that "it was only a provincial artizan audience"! You are welcome to that unjust and offensive sneer at the Bradford working men.

It only remains for me to request you to apologise for your editorial misrepresentation, and in particular, for the suppression of words on which you have chosen to found that misrepresentation.

Silvanus P. Thompson.

London, E.C.,
October 2nd, 1900.

[Prof. Thompson (in a somewhat discourteous style) asks us to apologise for two things, (1) the alleged misrepresentation due to (2) suppression of certain words. In reply, we must state that we had not the least intention to misrepresent Prof. Thompson's remarks; furthermore, we unreservedly accept his version of the matter. As to the intentional suppression of any of his statements, we did no such thing; in fact, our shorthand notes do not include any such words as we are charged with suppressing. However, as Prof. Thompson declares that these were spoken, we, of course, frankly accept his statement and regret their omission from our article. With all due respect to Prof. Thompson, we are still of opinion that to inform a "provincial artizan audience" that overhead trolley wires are out of place, even "in the centre of the city" of Bradford, and that to do it properly they must dispense with them, is likely to give a wrong impression. In the electric traction development now taking place throughout the kingdom, where is there an instance of surface contacts being tried, or in practical use?

It has yet to be proved that surface contact traction is the proper way of dealing with traffic in central thoroughfares. As we have before said, we hold no brief for any particular system; we want the best that comes along, but it is a fact that so far no method which has proved its superiority to the trolley has yet been practically introduced in this country.

Prof. Thompson admits that only one car was shown *without* overhead wires, which supports our contention that other surface contact systems were not in evidence. As to our reference to "only a provincial artizan audience"—well, we leave it to our readers to decide whether there is an unjust and offensive sneer in this; the discourse was advertised as a popular lecture to "artizans."—Eds. Elec. Rev.]

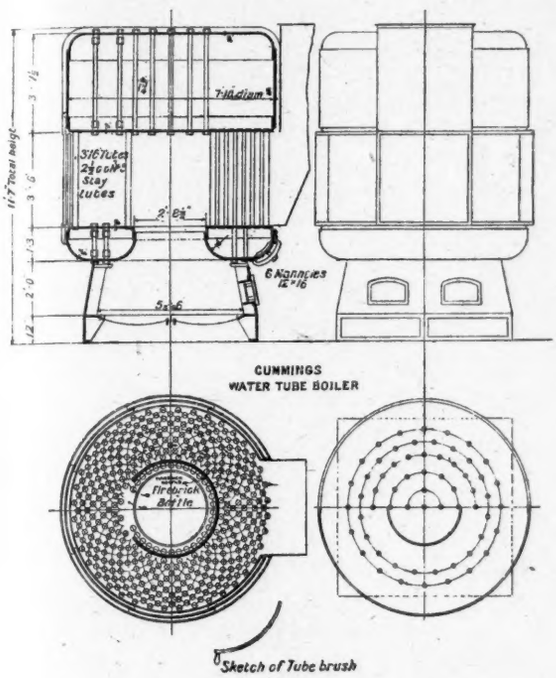
THE CUMMINS WATER-TUBE BOILER.

Our recent complaint that water-tube boilers were badly designed as regards the chemistry of combustion has already brought one protest from the makers of the Weir boiler. We have now received another from the makers of the Cummins boiler. This boiler, which we now illustrate, consists of an upper and lower drum connected by vertical water tubes arranged in an annulus. A central space has no tubes, and is lined with firebrick for purposes of combustion. The products of combustion rise from the grate into this refractory-lined chamber, one side of which is open. Through the opening the gases pass to the tubes, and travel round the annular chamber, passing amongst the tubes; these are 2½ inches in diameter, and are expanded into the tube plates. The stay bolts are made so as to be removable, and the ends of the tubes can be reached through the various manhole openings in the two drums, and thus removed or rolled into place with comparative facility. For this purpose four manholes are provided in the top drum and six in the lower drum. It is claimed that the only plate exposed to severe conditions is the bottom plate of the

lower drum, and this is made so as to be renewable with ease.

Owing to the disposition of the tubes along lines curved in plan, a tube brush can be inserted so as to clean the tubes on four sides, if we may so speak of a round tube. The boiler does not quite meet our ideas, in that it has one row of tubes in the combustion chamber that are not shielded by the clay lining. The area of tube thus exposed is, however, only a small percentage of the total heating surface.

The space for mud deposit does not appear large; it is, however, provided for by the protective influence of the fire-brick lining of the furnace. In construction, the boiler is built up of plain cylinders, uniformly circular flanged end-



plates and plain straight tubes and stays. The removable stays are, we think, novel, and experience is perhaps required as to their durability. We should have preferred a little better mud-drum space, but the boiler, as a whole, should be very free from stresses of unequal expansion, while the arrangement of the removable outer casing, and the accessibility of the tubes for brushing and internal scraping have been well provided for. We are not informed if the boiler has yet been put to the test of practical working.

Our illustrations are from a print of one of the smaller sizes of this boiler.

IONS, ATOMS, AND ELECTRONS.

At the recent meeting of the British Association at Bradford, an exceedingly interesting and somewhat amusing discussion on "Ions" took place before a joint meeting of Sections A and B. The discussion was opened by Prof. Fitzgerald, who made a strong attack on some of the accepted theories, but did not appear prepared to supply anything very satisfactory to take their place.

During the discussion Prof. J. J. Thomson's theory of the existence of electrified corpuscles * smaller than atoms also came on the *tapis*, and it appears that the bombshell discharged at the Dover meeting last year has now fallen in the chemical camp and caused considerable alarm. Prof. Armstrong declared that chemists were determined to stand by the structural integrity of the atom. The physicists are equally determined to break it up; Dr. Lodge hopes to break up the smallest atom into about 500 pieces, though Prof Fitzgerald would be content with knocking off a corner or two.

The following were the principal subjects for discussion proposed by Prof. Fitzgerald:—

1. What is the cause of ionisation, and what is its nature?
2. What is the source of the energy which keeps ions apart?
3. Ionisation does not obey the law of dissociation.
4. Different ions move with different velocities.
5. What is the nature of the double layer? Why do some substances attract positive electricity and others negative?
6. Ionisation in gases and liquids is not the same.
7. Do electrons gravitate, and have they a material nucleus?
8. The theory of magnetism and the nature of paramagnetism.

This list might be used as the basis of an examination paper for the London D.Sc. The well crammed candidates might supply answers to the questions; the examiners themselves seem as yet very much at sea. A *résumé* of the known phenomena of electrolysis may contribute to the understanding of the problems to be solved, and of the great advances that have recently been made in molecular physics—the meeting place of physics and chemistry.

When an electric current is sent through a solution of certain salts, each molecule of the salt is broken up into two distinct particles, one of which travels towards the anode and the other towards the kathode, where they finally make their appearance, if the chemical environment is favourable to their permanent existence. These wandering particles, as is well known, were called by Faraday "ions." The particle which moves towards the anode is the "anion," and that which moves towards the kathode is the "kation." The kation is usually a metal (or hydrogen), and the anion is the rest of the decomposable salt, or electrolyte. In very few cases do the anions or kations remain unchanged when set free at the electrodes: they usually undergo secondary chemical reactions with the water of the solution, or with other chemical substances present. Hydrochloric acid is one of the simple cases where there are no secondary reactions; hydrogen gas appearing at the kathode, and chlorine at the anode. Water is never primarily decomposed when a current is passed through an aqueous solution of an electrolyte. Absolutely pure water does not conduct at all. Conduction appears to take place in electrolytes by a convection process; the electricity being carried by the processions of ions.

Water being itself a non-conductor, *i.e.*, incapable of being split up into ions by a moderate electromotive force, what part does it play in the solution of electrolytes?

Kohlrausch first established the fact that the conductivity of solutions containing the same number of molecules of the electrolyte increases with the dilution till, at a definite limit, it reaches a maximum value.

In 1887 the famous dissociation theory of Arrhenius was put forward to explain the results of Kohlrausch. Arrhenius asserted that the molecules of electrolytes in aqueous solution are already dissociated into their two ions, which are loaded with their respective electric charges; and that electrolysis does not, therefore, require the splitting of the molecule by the electric current. According to Arrhenius the ions, under ordinary conditions, move irregularly to and fro among the water molecules, and one ion will sometimes approach and sometimes recede from an ion of the opposite kind; but when a difference of potential is established between the electrodes immersed in the solution, then the ions follow definite paths, the kation goes towards the kathode and the anion towards the anode, and they also move more quickly. The passage of a current through an electrolyte is altogether due to the free or dissociated ions, the undissociated molecules in the liquid take no part in the carrying of the current.

The explanation of Kohlrausch's result that the molecular conductivity increases with dilution is now evident in terms of the dissociation theory. When the aqueous solution of the electrolyte has reached its maximum conductivity, it means that sufficient water has been added to dissociate all the molecules of the electrolyte. A less quantity of water

* See Electrical Review, Vol. xlvi., p. 373.

dissociates only a part of the total molecules present, and the conductivity is correspondingly decreased. Chemically pure liquids, such as condensed hydrogen chloride, or 100 per cent. sulphuric acid, do not conduct, because, according to the dissociation theory, their molecules are not ionised.

This dissociation theory of ionisation has been widely accepted in Germany; but even its supporters admit that there are many unexplained difficulties connected with it. Fitzgerald, in the discussion above mentioned, characterised it as dynamically impossible. In the ordinary physical process of dissociation, energy is absorbed from surrounding bodies. This is not invariably the case in ionisation. Ostwald has shown that the process of ionising an atom is accompanied sometimes by a gain, and sometimes by a loss of energy. Fitzgerald also points out that in ordinary dissociation the molecules are not divided into elements with positive and negative electric charges, as is the case in ionisation.

It appears to be impossible, in view of these essential differences, to look upon ionisation as equivalent to physical dissociation. But what, then, is the cause and nature of ionisation, and what is the part played by the water in aqueous solutions of electrolytes? One ingenious explanation, depending on the high specific inductive capacity of water, has been suggested. A high specific inductive capacity implies that the molecule of the substance has a small electric moment. If we suppose a molecule to be represented by a needle with a positive electric charge at one end, and a negative electric charge at the other end, and suppose that this needle is suspended by an elastic fibre, as in a quadrant electrometer, then the deflection of the needle by a unit electrostatic field will be proportional, *ceteris paribus*, to the length of the needle. The deflection of the imaginary needle represents the specific inductive capacity of the substance, and the charges at the end of the needle, the electric charges of the ions of the molecules. It would follow from this theory that the ionic electric charges, in the molecule of water, must be much farther apart than in the average molecule. The ionic charges being the centres of attraction for external ions, the molecule of water would tend to separate the ions of any other molecule it came in contact with by solution. This ingenious theory deserves to be further investigated. Fitzgerald hinted that some experiments that had been made with ammonia as a solvent did not appear to support it.

Another interesting problem in connection with electrolysis is to explain why different ions move with different velocities. Hittorf was the first to establish this. He found that when a solution of sulphate of copper had been electrolysed for some time, the solution became more concentrated next the anode and weaker next the kathode. From this it follows that the centre of gravity of the sulphate has moved towards the anode. The explanation may be clear if we consider what takes place when two trains of equal length pass each other at different speeds. If the trains moved at the same speed their common centre of gravity would remain stationary; when the speeds are different the centre of gravity moves up or down the line with a speed equal to the difference of their speeds. The speed with which they pass clear of each other is equal to the sum of their speeds. We have only to suppose that the two trains represent two adjacent rows of anions and kations in a solution, and we can easily see that the sum of the velocities represents the conductivity of the electrolyte, *i.e.*, the number of ions with their electric charges liberated at the electrodes per unit of time, while the difference of the velocities represents the rate at which the concentration of the solution increases as we pass from one electrode to the other.

Since the free electric charge on an ion is proportional to its valency, the impelling force in a unit electric field must also be proportional to its valency. When the atomic weight divided by the valency was small, one would expect the velocity of the ion to be greater. This is true in a geneal way; hydrogen, for example, has the highest ionic velocity among the commoner elements. But no simple law has been discovered. The forces necessary to drive forward a gram-ion in a dilute solution have been calculated, and have been found to be enormous. For example, to drive forward 39·1 grams of potassium at a velocity of 1 centimetre per second would require a force of 38×10^6 kilograms. The cause of these great resistances to the movement of the ions has yet to be discovered.

Experiments made by Faraday led, in 1833, to the discovery of his famous law of constant electrolytic action. This law, in the form given to it by Helmholtz, states that the same quantity of electricity passing through an electrolyte either sets free, or transfers to other combinations, always the same number of valencies. On this law of Faraday's, Helmholtz founded his theory of the electric atom. The statement of this theory is as follows:—Every single valency of an elementary or compound ion is charged with exactly the same quantity of positive or negative electricity, which behaves as if it were an *electrical atom* that cannot be further divided.

J. J. Thomson* has quite recently shown that this electric atom is associated with a constant mass of matter, equal to about $\frac{1}{1000}$ of the mass of an atom of hydrogen, and that it has an independent existence. Fitzgerald proposes to call these electrified particles "electrons," and the name seems so good that it is likely to be adopted, though the term, we imagine, has already been used in a somewhat different sense.

The *savants* do not yet agree as to whether or not these electrons have a material nucleus. Dr. Lodge considers that the inertia they exhibit may not be due to the presence of matter, but to the self-induction of the moving electric charge. Prof. J. J. Thomson in his original paper discussed this view, but was not inclined to adopt it. There appears as yet, however, to be nothing to give it the direct negative. If the view is established, matter altogether disappears from the material universe and nothing is left except ether and electricity. Fitzgerald goes further, and says that the electron may be a mere strain in the ether, *i.e.*, the atom is a mere congeries of vacuous bubbles in the ether, and what we have been accustomed to look upon as the material part of the universe is nothing, the real substance being in the supposed empty space. Time will show whether our ideas of things are to be subjected to this startling revolution.

A considerable amount of new light has been thrown on the nature of electric conduction in gases, liquids, and metals by the electron theory. Gases conduct only when they are "electronised," *i.e.*, when electrons have been separated from the atoms by Röntgen rays, or some similar agency, and exist free in the gas, conduction consisting then of a convection current of electrons. Liquids or aqueous solutions of electrolytes, conduct only when they are "ionised" by the action of the aqueous solvent, the electrons dragging the ions along with them till the electrodes are reached, when they are detached and pass into the metallic conductor. Metals conduct by handing on the electrons from one atom to the other, without the atoms themselves being moved. Dr. Lodge pointed out that the metallic part of the circuit of a battery cell played an important part in regulating the flow of positive and negative electricity in opposite direction. The different velocities of positive and negative ions in the electrolyte would lead to the positive and negative electricities travelling at different rates in the circuit, but this is prevented by the mechanism of conduction in the metallic circuit.

The electron theory may help to elucidate the nature of magnetism. If the atoms of magnetic metals are in a state of rapid rotation, and if they consist of a congeries of electrons, then the revolutions of the electrons in their orbits correspond to the Amperian currents. The Zeeman effect supports this view, since it is completely explained by the assumption that a magnetic field is acting upon revolving electrified particles with the same mass and electric charge as have been calculated for electrons from other data.

The occurrence of electrons is by no means rare in nature. They have already been discovered in cathode rays, in Lenard rays, in Becquerel rays, and in rarefied gases acted upon by ultra violet light.

In the hands of the mathematical physicist the electron theory is likely in the near future to be applied to explain many additional phenomena. The chemists have not as yet much ground to fear for the integrity of their sacred atom; since all that the physicist is able to do as yet is to break off

* *Loc. cit.*

the very minute fraction of the mass of the atom represented at the most by a five-hundredth part. There is no prospect at present of realising the alchemists' dream of transmutation.

THE SYNCHRONISATION OF ALTERNATORS COUPLED IN PARALLEL.

[Condensed translation of the second and third parts of a paper entitled "A Study of the Transmission and Distribution of Energy by Alternating Currents," read before the Société Internationale des Electriciens by M. Maurice Leblanc.]

Oscillatory Movements of Alternators.

It is a general fact that oscillatory motions always tend to superpose themselves upon the rotary motion of alternators coupled in parallel. They cause variations of the effective voltage developed between the conductors of the distribution network, and, if their amplitude exceeds certain limits, they may cause the alternator, upon which they are imposed, to get out of step. The oscillations are caused by the periodic variations of the motor couple developed at the shafts of the alternator, and by similar variations of the resisting couple developed upon the shafts of the electric motors fed by the network.

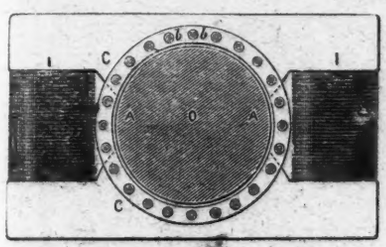


Fig. 1.

Without pausing to study the phenomenon of electro-mechanical resonance, which increases the amplitude of these movements, we shall indicate a method which allows us to reduce them as much as we wish.

Let us consider, in order to fix our ideas, the synchronous motor, diagrammatically represented in fig. 1. It is a two-pole motor of the Manchester type. Its armature, A A, can be arranged at will for single or polyphase alternating currents. We shall suppose, in what follows, that the armature is arranged for single-phase alternating currents.

The characteristic feature of this motor is the presence of a fixed magnetic screen enclosing the space in which the movable armature is placed. It consists of a series of copper bars parallel to the axis, O, of the motor, joined at their two extremities by two copper rings, C C, concentric with the axis. These bars are indicated by the circles marked *b*, *b*, on the figure. They cross the polar extensions of the field-magnet, I I, as close as possible to the iron.

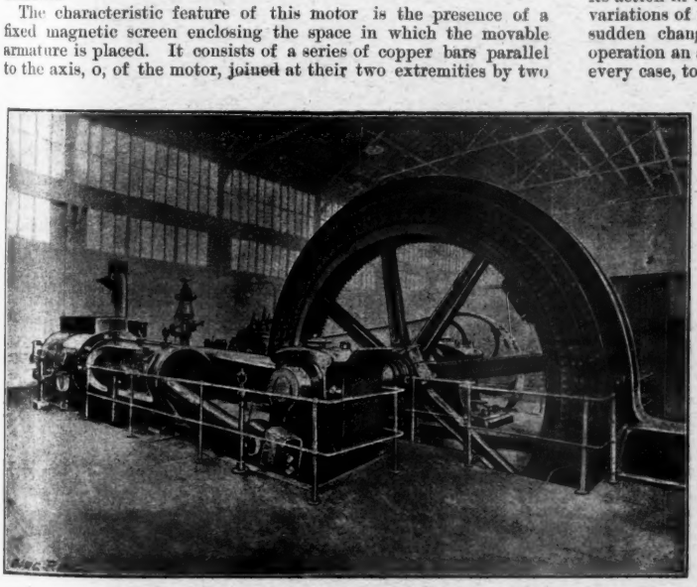


Fig. 2.

We shall see that this magnetic screen causes a rapid damping of the oscillatory movements with which the armature of the motor under consideration would be animated. Let us suppose that the armature is in synchronism with the single-phase alternating current of frequency *a*, with which it is fed. It tends to generate two magnetic fields, rotating with reference to itself with the speed *a*, but the one turning in the same direction as the armature, the other in the opposite direction.

The field which turns in the same direction as the armature has a speed of rotation in space equal to 2*a*. It cuts the closed circuits of the screen at that speed, and the cutting of its lines of force by the screen opposes its own development. The other field, turning oppositely to the armature, remains fixed in space, as long as it turns with the speed *a*. It can therefore develop freely across the circuits of the screen without inducing any current in them.

But if an oscillating movement is imposed upon the motion of rotation of the armature, the direction, in space, of this latter field participates in that movement—hence the production of powerful Foucault currents in the circuits of the screen, a large consumption of energy, and consequently a rapid damping of the oscillating movements. That is why we have called the circuits, closed on themselves, and constituted as we have stated, damping circuits (*amortisseurs*).

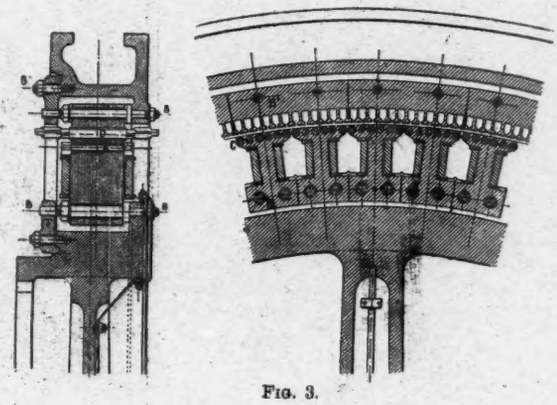


Fig. 3.

The regulating action thus produced by the magnetic screen is the more effective, other things being the same, in proportion as its closed circuits are better conductors, and as they more fully enclose the field developed by the armature. But the presence of this screen has other advantageous consequences. By opposing the development of the flux rotating in the opposite direction to the armature, which is created in the latter, it extinguishes a large portion of the noise, often intolerable, that single-phase alternators produce.

If we apply this screen to a polyphase alternator, it adds to the stability of the synchronism, and, if it does not lessen the inductive reaction in the same proportion as with single-phase alternators, its action in this sense is always beneficial, for it opposes all rapid variations of flux in the magnetic circuits. For the same reason, the sudden changes created in the network, notably by putting in operation an asynchronous motor with a squirrel cage, are found, in every case, to be very much weakened by its presence.

We were led to employ these damping circuits when we were trying to correct the currents furnished by the secondary circuits of a transformer, for the oscillations of synchronous motors. The good results furnished by this arrangement have induced M. Farcot to apply it to some large alternators driven by the single cylinder engines of his system. The employment of single cylinder engines is very economical, but the regularity of the motion of rotation which they give, is never so good as that obtained with twin engines, and the synchronisation of alternators so driven is difficult. It has been applied with success to the single-phase alternators, turning at 60 revolutions, of the Sector of the Champs Elysée, Paris, one of which is represented in fig. 2. Fig. 3 shows how the *amortisseurs* are placed.

The electrical works of St. Ouen have also been furnished with two diphase alternators on this system, turning at a speed of 67 revolutions. Fig. 4 represents this installation. These alternators are connected in parallel, and as they feed some rectifier transformers, in order to increase the regularity of the frequency of alternation, we couple the machines together when the cranks of their steam engines are at right angles. The regularity of the frequency is then the same as if we had only one alternator driven by twin steam engines, and the connection effected by the electrical actions replaces the mechanical connection.

We do not think that a similar result has yet (1899) been obtained in current practice. Other applications of this system have been made, notably at the electric works of Saumur, or are in preparation in France or abroad.

The Properties of Single-phase Induction Motors.

We shall first deal with the theory of single-phase alternate current machines, because nothing will be easier than to extend it to the case of polyphase machines, while the converse would not be correct.

In order to facilitate the exposition of this theory, we shall consider an induction machine (single-phase alternator) constructed in a special manner, and as we are about to describe. Its primary, AA (see diagram, fig. 5), is composed of a ring of the Pacinotti type, with $2n$ poles (six in the figure), whose channels are of varying depths, in order that different numbers of turns of wire may be placed in them. The system of winding adopted is represented on the diagram.

If we call ν a constant number of turns of wire, and β the angle made by the diameter passing through the centre of one of the channels with a diameter $x\,y$ taken as origin, the number of turns of wire in that channel, N, is found from the expression $N = \nu \sin \beta$. Two rings, b_1 and b_2, turning with the rotor, and upon which the brushes, f_1 and f_2, bear, serve as points of entry and exit for the current.

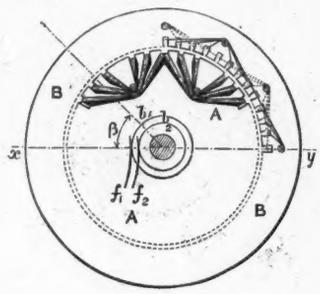


Fig. 5.

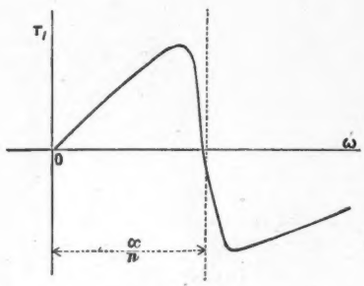


Fig. 6.

The secondary circuits, two in number, are arranged along a crown of iron plates, B B, with teeth pointing inwards. Their mode of winding is similar to that of the rotor. We have represented diagrammatically, in fig. 5, the winding of the first circuit in full lines and that of the second by dotted lines.

If we call ν' a constant number of turns of wire, and β the angle that the diameter passing through the middle of a channel of the crown, B B, makes with the diameter $x\,y$ taken as origin, the numbers N_1 and N_2 of turns belonging to the two secondary circuits, which will be placed in this channel, will have respectively the expressions,

$$N_1 = \nu' \sin n\beta \qquad N_2 = \nu' \cos n\beta.$$

These secondary circuits are closed on themselves.

The author of the paper here proceeds to find expressions for the currents in the two stator circuits, involving speed and frequency, and an expression for the mechanical torque developed at any instant, by the rotation of the inductor, and its mean value per second, both in terms of the speed and frequency.

From this the author proceeds:—If we represent by a curve the variations of the couple developed in the machine as a function of the speed, the current strength being supposed constant, this curve will take the form shown in fig. 6. The couple is zero when the speed is zero, it increases rapidly with the speed to a maximum, and returns to zero when the speed approaches synchronism. It then changes sign, becoming opposed to the action of the current, passes through another maximum, and continues to decrease as long as the speed continues to increase.

It results from the preceding that a single-phase induction motor, whose primary is traversed by a current of constant effective strength, can furnish mechanical energy, or absorb it, according to the speed at which it is turned. When it absorbs mechanical energy, it in reality behaves as a generator.

The author next works out an expression for the strength of the current traversing the primary, when an alternating difference of potentials is established between its terminals.

This current can be considered as the super-position of two currents, one whose strength is of the same phase as the E.M.F., the other whose strength will present a difference of phase of a quarter of a period with that E.M.F.

Following the established usage, we shall call these currents the effective current and the wattless current.

The wattless current only serves to generate magnetic flux.

The effective current takes from, or furnishes energy to, the source of E.M.F. which maintains the difference of potential between the terminals of the primary, according to the sign of a quantity which changes sign when the speed of rotation of the rotor is in the neighbourhood of synchronism.

The machine under consideration will therefore furnish energy to the source of E.M.F. acting between its terminals, and, consequently, will operate as a generator, if we impress upon its rotor a higher speed than that of synchronism.

(To be continued.)

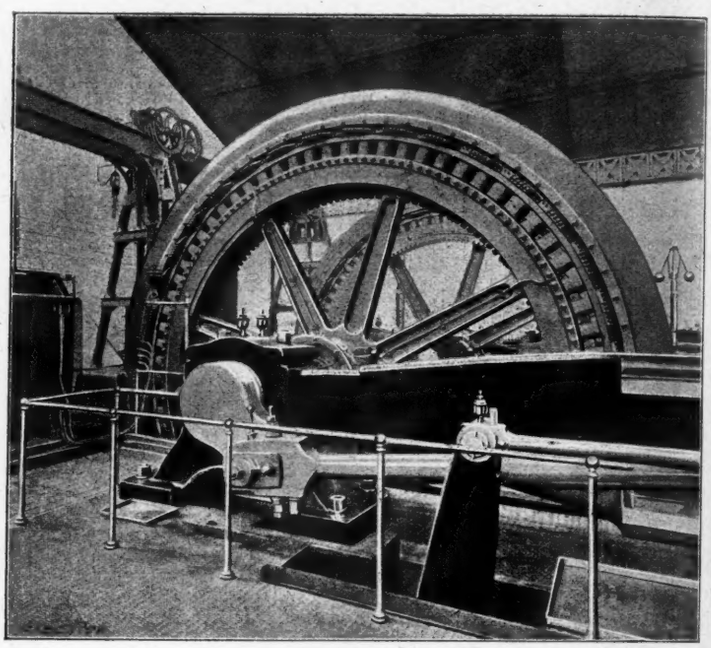


Fig. 4.

BUSINESS NOTES.

Artistic Fittings.—Messrs. W. A. S. Benson & Co., of New Bond Street, artistic metal workers and electrical engineers, are to be congratulated on receiving the only gold medal for electric fittings awarded to the British Section at the Paris Exhibition. Messrs. Benson have always been celebrated for the artistic purity of their designs, which have done for electric lighting in England very much what William Morris did in other branches of decoration. In fact, it may not be generally known that Mr. Morris and Mr. Benson were practical collaborators in the revival of taste which came about some 20 years ago, and that much of the early Morris furniture was Mr. Benson's design. The Benson firm made a specialty of artistic house and church lighting, and are now engaged on the important contract for lighting St. Paul's Cathedral. Cambridge University, the Ryland's Library at Manchester, and the Parliament buildings of Melbourne can also testify to their taste, while the electric fittings in the exquisite little National Pavilion at Paris were mostly supplied by them.

Books Received.—"The Struggle of the Dutch Republics." By C. Boissevain. Amsterdam: "Standelsblad" Office. 6d.

Year Book for 1890-1891 of the Armour Institute of Technology. Chicago: Armour Institute of Technology Press.

"Mathematical Drawing and Measuring Instruments." By W. F. Stanley. Seventh edition. London: E. & F. N. Spon. 5s.

Bulletin of the Association des Ingénieurs Electriciens. Sortis de l'Institut Electrotechnique Montefiore. Vol. XI.

"The A B C of Electricity." By W. H. Meadowcroft. Sixth edition. Manchester: John Heywood. 2s.

"Injectors: their Theory, Construction and Working." By W. W. F. Pullen. Second edition. Manchester: The Technical Publishing Company, Limited.

Kenilworth.—We are informed that the public lighting, to which we referred in our "Light and Power Notes" not long ago, is being carried out with overhead conductors by the Birmingham Installation Company, who originally put down Mr. Mitchell's private lighting plant. The same firm has secured the contract for "free" wiring in the town of Dudley.

Electrical Wares Exported.

Week ending Oct. 3rd, 1899.		Week ending Oct. 2nd, 1900	
Adelaide. Teleg. mat.	£658	Alexandria	£140
Brisbane. Teleg. mat.	3,446	Amsterdam	30
Buenos Ayres Teleg. mat.	662	Auckland	90
Calcutta	694	Buenos Ayres	95
Cape Town	114	" Teleg. mat.	842
Chinde. Teleg. mat.	988	" Teleph. cable	125
Colombo	114	Calcutta	248
Copenhagen. Teleg. wire	26	Cape Town	211
Durban	103	Cochin	21
" Teleg. mat.	63	Copenhagen. Teleg. wire	247
East London	160	Durban	250
Hamburg. Teleg. mat.	100	" Teleg. plant	147
Helsingfors	36	" Teleph. mat.	170
Hobart	24	Fremantle	164
Lourenco Marques. Teleg. mat.	349	Gibraltar	136
Malta	63	Hamburg. Teleg. mat.	400
Melbourne. Teleg. wire	2,783	" Teleph. appar.	406
Montreal	70	Hong Kong	76
Oporto	45	Launceston. Elec. motors.	281
Perth	70	Lisbon	50
Port Amelia. Teleg. mat.	1,415	Lyttleton	300
" Elizabeth	350	Melbourne	206
" Said	336	Monte Video	46
Rio Janeiro. Teleg. mat.	3,312	Ostend	20
Rockhampton	42	Otago	56
Rotterdam	20	Port Chalmers	39
St. Petersburg. Teleg. cable	99	Port Elizabeth	22
Shanghai	75	" Teleg. mat.	478
Sydney	817	Port Said	8
" Teleg. mat.	721	Rio Janeiro	142
Trinidad	45	Rosario. Teleph. mat.	210
Wellington	301	Rotterdam	16
" Teleph. mat.	567	St. Petersburg. Teleg. paper	70
Yokohama	78	Singapore	54
		" Sub. teleg. cable	50,000
		Stockholm. Teleg. wire	360
		Sydney	336
		" Teleg. mat.	120
		" Teleph. cable	895
		Valparaiso	80
		" Teleg. wire	344
		" Telephone	70
		Vera Cruz. Teleg. mat.	73
		Wellington. Teleg. mat.	492
		" Teleph. mat.	68
		Yokohama. Teleg. cable	12,895
		" Teleg. wire	655
Total	£17,997	Total	£71,167

Foreign Goods Transhipped.

Antwerp. Elec. machinery	£50
Port Amelia. Teleg. wire	920
Total	£970

Bankruptcy Proceedings.—A receiving order was made on debtors' own petition on September 26th at the Bankruptcy Court against T. W. Greaves and W. G. Randall, electrical engineers and cycle manufacturers, lately trading in co-partnership at East India Dock Road and Greenwich.

A first and final dividend of 2s. 8½d. has been announced in *re* B. Symmons, electrical engineer, Brighton.

Liquidations and Dissolutions.—The St. Stephen's Electrical Syndicate, Limited, decided at a meeting at Uxbridge Road, on September 24th, that Mr. A. H. Tessier, 1, Arthur Street East, E.C., be the liquidator in the place of Mr. F. H. Ebsworth, deceased.

We have received the following letter from Messrs. Claud Hamilton, Limited:—

"Referring to the official notice which appeared in the *Edinburgh Gazette*, of the final meeting of Claud Hamilton, Limited (in liquidation), an extract of which has been published in several of the trade gazettes: As we find that this notice has caused considerable misunderstanding amongst some of our correspondents, my directors desire me to explain that the said notice does not apply to this company, but to the old private company, which went into voluntary liquidation in 1898 for the purpose of the reconstruction and transfer of the business to the present and larger company.

"I shall be obliged if you will be good enough to publish this explanation, in order to avoid any further misunderstanding.

"Yours faithfully,

"*For* Claud Hamilton, Limited,

"David Alexander, *Secretary.*

Glasgow, *September 29th*, 1900."

A meeting of the Western and Brazilian Telegraph Company will be held at Winchester House on November 7th, to hear an account of the winding-up proceedings from the liquidator, Mr. W. H. Axworthy.

Catalogues and Lists.—From the General Electric Company, Limited, we have received a copy of their electric bell catalogue, Section "L," thirteenth edition, containing all matters appertaining to electric bells, batteries, indicators, lightning conductors, speaking tubes, &c., together with diagrams and instructions; also their electric wire and wiring supplies list, Section "W.," tenth edition, containing everything appertaining to electric wires, conduits, line material and accessories. This is the first time that this has appeared as a separate section, and special attention is called to the difference in discount. The increased cost of metals, other raw materials, and the cost of production notwithstanding, list prices have been reduced without in any way lowering the high standard of quality.

The Morley Electrical Engineering Company, Limited, of Morley, have issued a trade price list of their standard C.C. dynamos and motors for rope or belt driving. Details are given in a handy tabulated form, and a standard specification is included.

A pamphlet has been issued by the Edwards Air Pump Syndicate, Limited, of Crown Court, E.C., describing their patent air pump, which is being used in connection with electric power, lighting and traction, and other land installations, and is being manufactured under license by the leading English engine builders. At Glasgow, Manchester, Liverpool, Salford, City of London, Westminster, Kensington and Knightsbridge, and St. Pancras electricity works they are employed; also at the City and South London and Waterloo and City Electric Railway power stations, and in connection with the Newcastle Corporation's electric traction scheme. The list before us describes the pump and gives results of recent trials.

Coal.—We have received a copy of the first issue of the *Coal Merchant and Shipper*, a weekly journal published in London (165, Strand, W.C.) devoting itself to the interests of the retail and export coal trade. Electrical engineers in charge of electricity supply undertakings are very deeply concerned in the matter of coal, and we have no doubt that they would find something of assistance to them in this journal. Its first number has a businesslike appearance.

Cotswold.—The Hart Accumulator Company, Limited, have secured the order for the supply of storage battery required by the Cotswold Sanatorium for their electric lighting.

For Sale.—Messrs. Wheatley Kirk, Price & Co. are offering certain electrical plant for sale, including a 120-kw. steam alternator and exciter, a 25-kw. ditto, surface condenser, two 60-h.p. Peache engines and Crompton-Brunton alternators, switchboards and transformers, also two 40-h.p. Willans engines and Elwell-Parker continuous current dynamos, and a 20-n.h.p. Tangye gas engine. See our "Official Notice" pages to-day.

The Oldham Electric Light Committee invites offers for two 60-kw. shunt-wound dynamos (J. P. Hall & Co.). See "Official Notices" to-day.

The Hart Push Switch.—The switch which we show in the illustration below is, we are informed, being recommended in specifications of some consultants on account of their neatness and good construction. Messrs. H. M. Salmony & Co. experimented extensively with the push button type of flush switch before introducing the Hart switch to the market. The mechanism is neither frail (allowing it to be easily broken) nor so heavy that it is difficult to operate the switch. Messrs. Salmony claim to have overcome these difficulties, and to have produced a switch which is strong and durable, and yet easily operated, and of which the action is positive. The

mechanism is encased in one piece of porcelain. The contacts are of bronze, and of the knife switch form. The switch has a long break, and the switch-plate is thoroughly insulated from the mechanism. These switches may be installed in gangs without the use of backplate, but they are recommended for use with an iron frame or box whenever possible. The position of the push buttons indicate whether the switch is on or off. The flush switches are furnished either in nickel, bronze, or polished brass. Oxidised finishes and special finishes to match hardware are furnished at slight additional cost. The switches are made either single-pole, double-pole, two-way, or three-way.

Lighting Exhibition in Vienna.—The rapid development which all branches of lighting industries have made during the last few years has led the interested trades in Austria to arrange to hold in November of this year, in the Gartenbau-Salen, an exhibition of all branches of the lighting industries and their kindred trades. This idea has met with much support in the circle interested, and the many novelties already announced show that a very interesting exhibition will be formed. The Hon. Committee is composed, among others, by his Excellency the Statthalter Errich Graf Vielmannsegg, Hofrath von Waltenhofen, Prof. Nernst, Rekton, Prof. Lickler, Herr Hanst, Prof. Loose. The Exhibition offices are at I. Hothringer Strasse, 15.

(*Continued on page* 551.)

THE NEW ELECTRICITY WORKS OF THE GLASGOW CORPORATION.

(*Continued from page* 509.)

The positive and negative storage batteries are situated in separate rooms, on the right and left hand of the entrance hall. These lofty rooms are extremely well lighted and ventilated, the whole of the roof consisting of glass and iron, and the walls being faced with white enamelled bricks.

Each room contains a battery of 167 Tudor cells, of the 19 plate L B type, contained in leaden boxes; the cells have a capacity of 1,100 ampere-hours, *i.e.*, 150 amperes for 7⅓ hours, and are capable of discharging at a maximum rate of 330 amperes without injury, when necessary. The individual boxes are carried on heavy glass slabs supported on glass oil-insulators, which are themselves supported by steel H girders, covered with lead trays. The steel beams are again insulated from the floor by Tudor earthenware oil-insulators, and the floor is covered first with a layer of sulphur, then with asphalte, so as to be as far as possible acid proof, and at the same time insulating.

The regulating cells are 50 in number, in steps of two cells, and, as will be seen from our illustration, are arranged cross-wise, for convenience of access to the connecting cables. The whole of the latter are carried, as far as possible, beneath the floor level, so as to avoid interruption to the view and the unsightliness of overhead conductors; the success of this plan is strikingly apparent.

The minimum discharge pressure being 1·8 volts per cell, the lowest pressure, with all cells in, is 300, and with all the regulating cells cut out, 210 volts. The regulators of both batteries are connected with the middle wire, the other ends of the batteries being coupled direct to the outers of the three-wire system; by this means, as the middle wire is earthed, the whole of the regulating apparatus is always within 125 volts of earth potential, a condition which renders shocks to the person highly improbable.

The battery regulating switch gear is of an entirely novel type, designed by Mr. Chamen, and built by Messrs. Jas. White, of Glasgow. The regulator itself extends the whole length of one side of the battery room, and the contacts are arranged so that the shortest possible amount of cable is required between the regulating cells and the regulator. The apparatus consists of a rail in the form of an H section girder; attached to this rail are wrought-iron brackets, on which large gun-metal contacts are fixed, insulated with substantial vulcanite insulators. Forming part of the contact shoe is a cable socket, into which the cable connected to the cells is sweated. Another very novel feature of this regulator is the form of the brush contact gear. This consists of a trolley running on a rail extending the whole length of the battery room; it is moved by means of wire rope passing round a drum at each end. These drums are geared to hand-wheels near the dynamo switchboards in the engine room, and large indicating wheels are provided, showing at a glance the position of the contact trolley in the battery room. The contacts on the trolley are in the form of laminated rings, making contact on both sides of the fixed contact shoes. A substantial pilot contact and pilot resistance are also carried on the trolley, which passes from contact to contact with hardly any perceptible spark.

A useful device has been added by Mr. Page, resident engineer at Port Dundas, for the purpose of testing the insulation of the neutral conductor; this consists of an insulated copper wire stretched alongside the battery regulator, and connected, by means of a small contact spring carried on the trolley, with the contact *next* to that on which the main switch rests. The stretched wire is connected with a switch in the engine room, by which it can be earthed through an ammeter while the neutral wire is for the moment disconnected from earth. There will then be a potential difference of 4 volts between the neutral wire and earth, causing a current to flow whose magnitude is a measure of the insulation resistance of the neutral.

The last few regulating cells at the end of each battery are arranged so that they can readily be isolated from the main battery and used for such purposes as meter testing, milking sick cells, &c. With this object, large gun-metal studs are sweated into the terminal bars of each cell, and provided with massive two-handled nuts for clamping cable connections.

As all the cells are on one level, they are extremely easy of access for renewal or repairs.

Returning now to the engine room, we proceed to the consideration of the switch gear. It is in this connection, perhaps, that the most striking novelties of the Glasgow stations are exhibited. Departing altogether from the conventional types of switch gear, Mr. Chamen has succeeded in designing an equipment in which the qualities of strength and simplicity are combined to the highest degree, while all parts are perfectly accessible, and extensions present no difficulties whatever.

The switchboard gallery itself is of novel construction, being built of iron and paved with glass blocks in such a way that it is almost impossible for the attendants to make contact with earth near the switch gear. The gallery extends the whole length of the engine room, and carries all the feeder panels, as well as the balancer and battery boards. The engineer's room abuts directly upon it at the centre, and at the same time commands a clear view of almost every part of the engine room, while several stairways give ready access to the ground level.

The system of working is as follows:—Each generator is provided with a separate switchboard, placed under the gallery opposite the machine, and consisting of two separate panels, some distance apart, for the positive and negative poles of the dynamo. Four positive and four negative bus bars run along beneath the floor of the gallery, with which any of the generators may be connected. The feeder panels on the gallery are divided into sets of eight positive and eight negative feeders, placed side by side, so that positive set alternates with negative; to place all the positives at one end and the negatives at the other would obviously be quite impracticable with the great length of switchboard already installed, let alone the future additions, and it is questionable whether any advantage would be gained by doing so, even if it were possible. Each compartment provides for two feeders, and is fitted with plug switches, by means of which either feeder may be coupled to any one of the four bus bars; the main emergency switches and fuses are placed on corresponding panels behind the plug panels, the switches being operated from the front of the boards.

We give herewith views of the generator boards at the north and south ends of the engine room respectively. In the foreground of the former are three panels supplied by Messrs. Laing, Wharton & Down, with the Walker generators; the outers of these are provided each with a minimum current cut-out, main switch and duplex fuse, as well as a four-way plug switch of the type devised by Mr. Chamen—*i.e.*, with foliated copper S-shaped plugs—and a Kelvin recording ammeter. The middle panel bears a main switch and duplex fuse for each generator; the shunt regulators and Kelvin multi-cellular voltmeters are mounted on either side of the middle panel.

The panels are of thick marble, carried in a steel frame, and securely held by means of grooves cut in the top and bottom edges; between the steel and the marble there is a layer of soft material to avoid splintering the marble.

The temporary ends of the bus bars are shown in the view, which also indicates the method of supporting the same in earthenware insulating yokes.

Beyond the balancer panels is an interesting "relic," consisting of the last remaining portion of the temporary wooden shed which formerly covered this end of the site; the old station voltmeters are mounted on this wooden pillar, and it has been found convenient to leave them in their original position until the last.

The other view shows the positive and negative panels connected with the second of the British Thomson-Houston generators; practically the same description applies to these as to the balancer outer panels, but here the gear is much heavier, being capable of carrying 2,000 amperes; there is only one cut-out, of the Andrews non-return current type, and one recording ammeter.

The switchboards for the three large sets were made by Messrs. Cowans, Limited, of Dukinfield. Those for the 200 and 400 H.P. sets were supplied by Messrs. James White, of Glasgow, and are generally similar to the larger

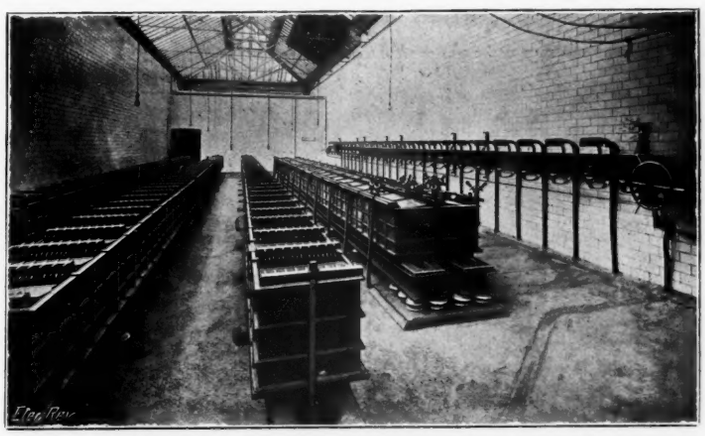
A pamphlet has been issued by the Edwards Air Pump Syndicate,

(Continued on page 551.)

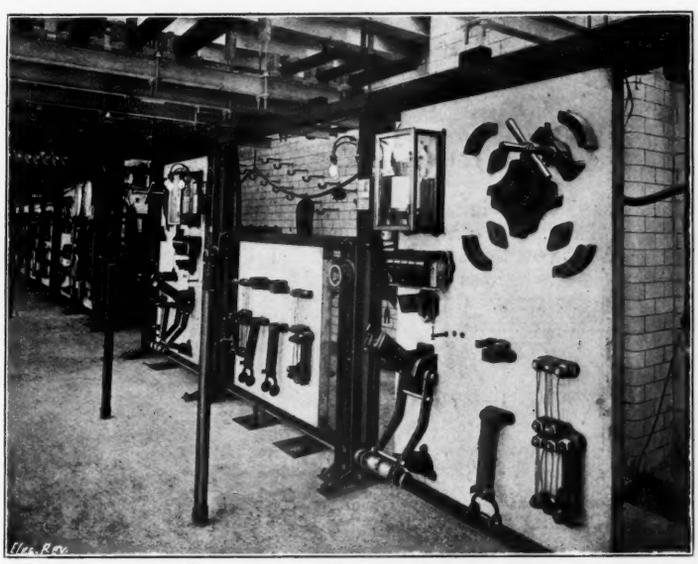
ones, but are fitted with Ferguson & White's automatic circuit breakers. The boards for the two 2,400-H.P. sets about to be installed are being put in by Messrs. Mechan & Sons, of Glasgow. They are of the same pattern as the rest, but are designed to carry a load of 4,000 amperes each.

Above the switchboards are to be seen the bus bars with their expansion bends, and the heavy copper connections leading upwards to the feeder panels and downwards to the generators.

The bus bars consist of a series of eight heavy soft copper bars running the whole length of the station, four bars being allotted to each polarity. These bars are built up throughout their length, and consist of 22-feet lengths of solid rolled copper. At each joint a series of thin _∩_∩_ shaped pieces are bolted to allow for expansion. Each set, positive and negative, measures some 225 feet in length. The two heavy "station" bars each consist of one heavy bar, 4 inches broad by 1 inch thick, to which are bolted by several steel bolts, three bars, ½ inch thick, and of the same width. The remaining six bars are made up similarly, but are of less sectional area, being composed of one 4 inches × 1 inch bar, and one 4 inches × ½ inch bar; the steel bolts, however, are left long enough to allow of the sectional area being increased at any time by simply adding to the number of bars. Throughout their length the bars are kept spaced apart for ventilation purposes by means of accurately faced copper washers.



One of the Batteries.



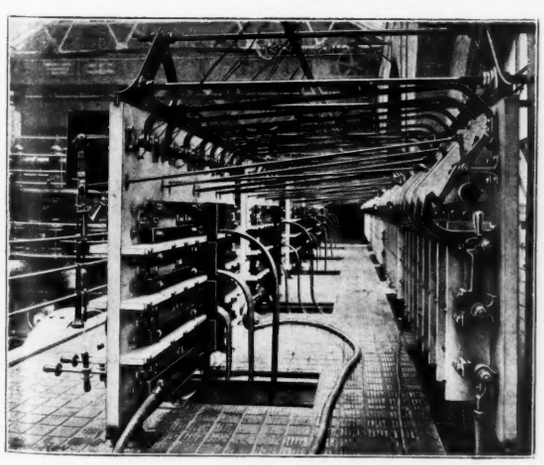
Steam-Balancer Switchboards.

Connections are made between these copper bars and the dynamo and feeder panels, by means of heavy copper bars of sufficient section, and bent in such a way as to allow for expansion.

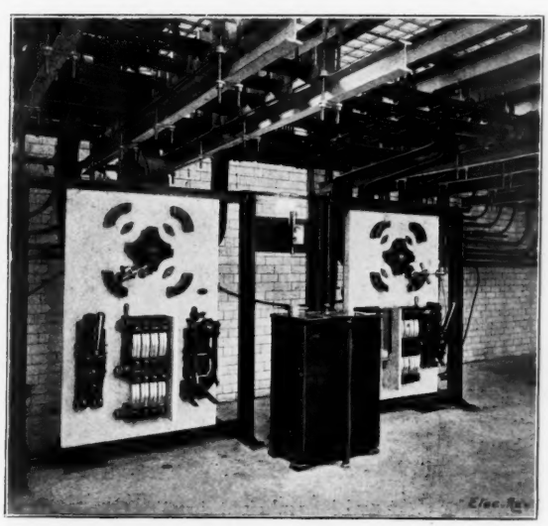
Throughout their whole length the bus bars are supported on H iron girders, from which they are insulated by heavy porcelain chairs shaped to fit the girders; the latter are supported by adjustable screws fixed at one end to the H iron girders composing the floor of the switchboard gallery.

The whole of the copper used for the bus bars, some 40 tons, was supplied by Elliot's Metal Company, and the erection of the bars was carried out by Messrs. Mechan and Sons, Glasgow, who also constructed the switchboard gallery itself, and supplied and fixed the cast-steel stools and guides by which the feeder panels are supported.

As already stated, the feeder switchboards are mounted on the gallery; they are necessarily somewhat more elaborate in appearance than the generator boards, owing to the great



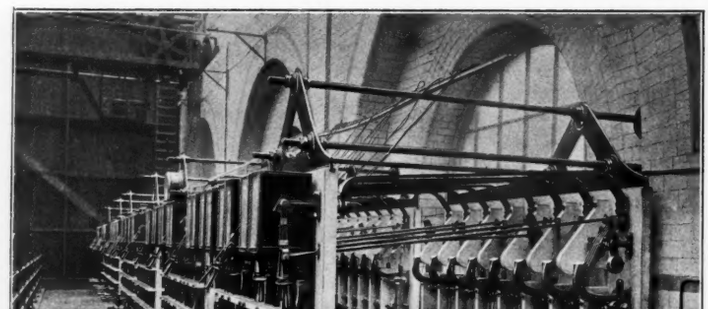
Feeder Switchboards: End View.



2,000-ampere Dynamo Switchboards.

F

number of feeders to be dealt with—no less than 40 of each polarity being provided for, while 25 pairs are already in use. They are of substantial construction, consisting of white marble slabs, 5 feet 6 inches high × 4 feet 4 inches wide × 3 inches thick, and are fitted with marble partitions of dimensions sufficient to prevent any possible contact being made between adjacent feeders. The marble slabs are polished on both sides, and are grooved at the top and bottom to fit the stools and guides in which they are carried, and which are heavily insulated from earth.



Feeder Switchboards: View of Six Sets.

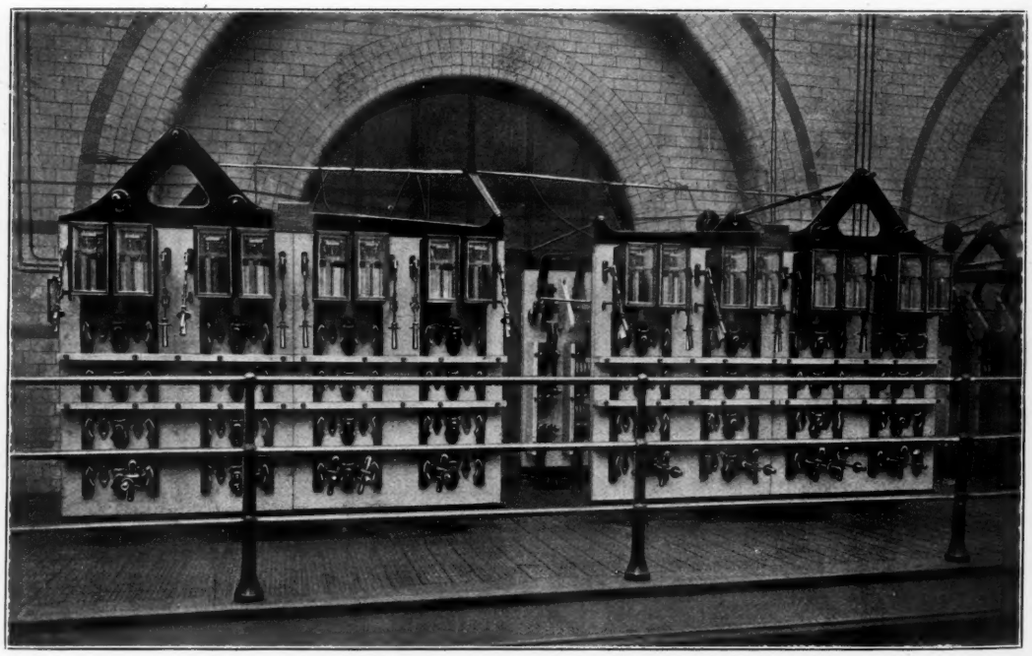
The panels are arranged in two rows, one row, carrying the emergency switches and fuses, being close to the wall, and the other, bearing the plug switches and recording apparatus, 6½ feet in front.

Each set of panels consists of four slabs, two in each row, providing for eight feeders of one polarity. The corresponding eight feeders of the other polarity are connected with the adjacent set of panels, so that the distance between positive and negative is never more than a few yards. Our front view of some of the feeder boards shows a complete group of panels for eight positive and eight negative feeders. The respective polarities are indicated by red and blue enamel applied to those parts of the apparatus which are not polished.

It will be seen that each separate front panel bears two recording instruments, two vertical bars, and four contact blocks, as well as the lever handles for operating the emergency switches on the hindmost row of panels.

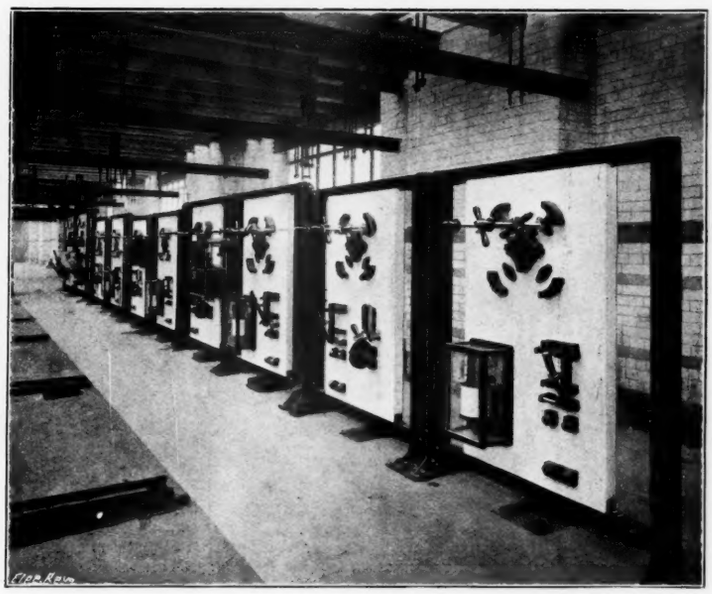
The recording instrument is of novel design, suggested by Mr. Chamen, and now known as the Kelvin "feeder log." It gives a continuous record of the current going out to a feeder and of the pressure at the feeding point.

The solenoids of these instruments, of which we give an illustration (p. 550), are made from high conductivity copper tubes cut with radial slots, and put together in such a way that the axis of the solenoid exactly coincides with the axis of the field. A sufficient number of turns is employed to give an exceedingly intense field, a very necessary condition in all central station instruments. The case has been specially designed for convenience in changing record sheets, refilling the pens, &c.; to open the instrument the glass front is pulled out at the bottom, raised up and slid back on the top of the case, and the scale and guides are then lifted to a horizontal position, enabling the clock to be pulled forward. A special device allows it to take up a horizontal position outside the case where most convenient for changing the papers. The clocks on these instruments are all actuated by a pawl and ratchet gear controlled by a handsome regulator mounted on the gallery, which closes a circuit every half minute. Besides recording the current and pressure, the instruments also indicate their actual values at each instant on a vertical scale.



Front View of Positive and Negative Feeder Switchboards.

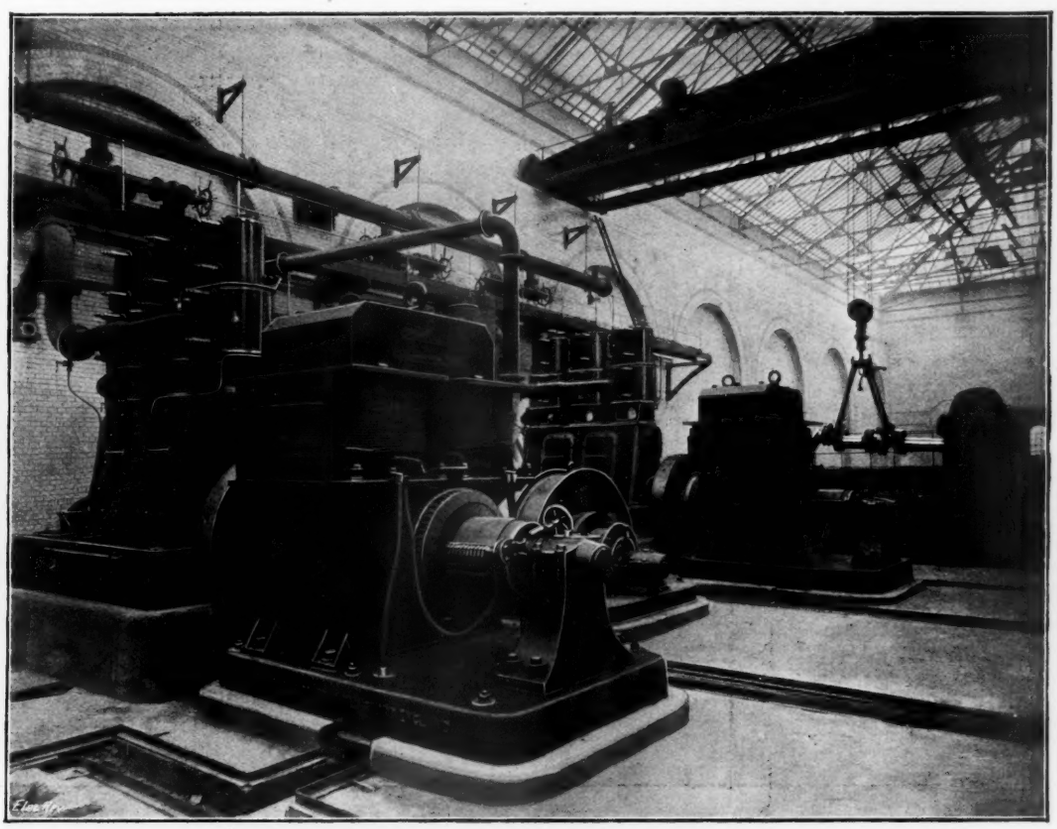
The vertical bars consist of single forgings of high conductivity copper, without joints; each of these is connected with one of the feeders through the apparatus on the corresponding hinder panel. Between each pair of vertical bars are four contact blocks of forged copper, which are joined through the marble to horizontal bars on the back of the board; the latter are connected with the main bus bars underneath the floor of the gallery by freely curved copper bars, and are provided with expansion joints in the middle of their length, as shown in our view of the back of the board. By means of "S" plug switches any feeder can be connected with either of the four bus bars. These switches are so arranged that after turning through a right angle—to the normal "on" position—they cannot be turned backwards, nor can they be withdrawn without turning through another right angle, beyond which they cannot be turned. Although it is not intended to use the plug switches for making or breaking circuit, carbon sparking pieces are fitted on the contact blocks, so that the full current can be broken without injury to them.



Dynamo Switchboards at Pollokshaws Road.

From the front panel the current is carried overhead by bare copper rods to the emergency switches. These are composed of several pivoted copper bars engaging with fixed jaws, giving a double break; one of the bars is arranged so as to lag behind the rest, breaking quickly under the action of a spring, and the spark is taken by carbon blocks. The switches are operated by steel connecting rods, controlled by lever handles on the front panels, with locking devices for the on and off positions.

Beneath the main switches are the duplex fuses, provided with heavy forged copper links, by means of which either of the fuses can be brought into action or short-circuited. There is ample room for free passage between the two rows of panels, and it is obviously a great advantage to have the blinding flash of a fuse, breaking, possibly, some thousands of amperes, well screened from the eyes of the attendants.



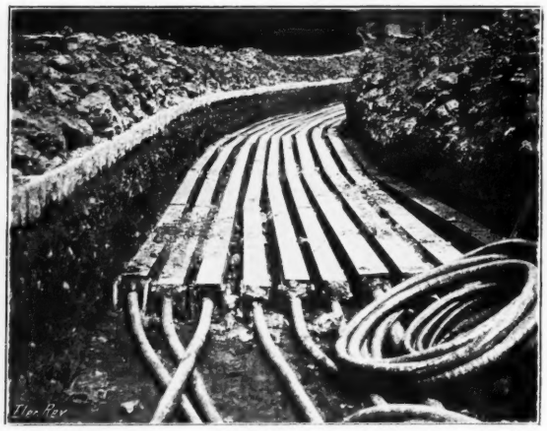
View of Engine Room at Pollokshaws Road.

All the feeder connections are designed to carry 1,000 amperes each, with a wide margin.

The whole of the 48 feeder panels at present installed were made by the Holland House Electrical Manufacturing

Company, Limited, of Glasgow; two additional sets are in course of erection, one made by Messrs. James White, and the other by the Holland House Company, who are also constructing two other sets, which will be divided between the Port Dundas station and that at Pollokshaws Road.

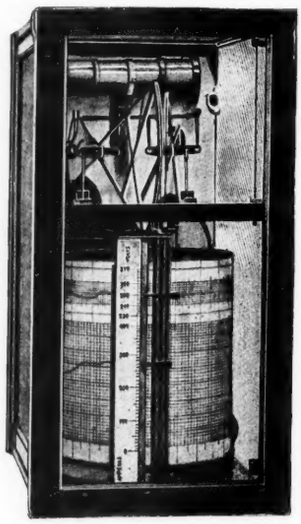
The middle wire and battery panels were constructed by Messrs. James White; this firm also has in hand three other sets of feeder panels.



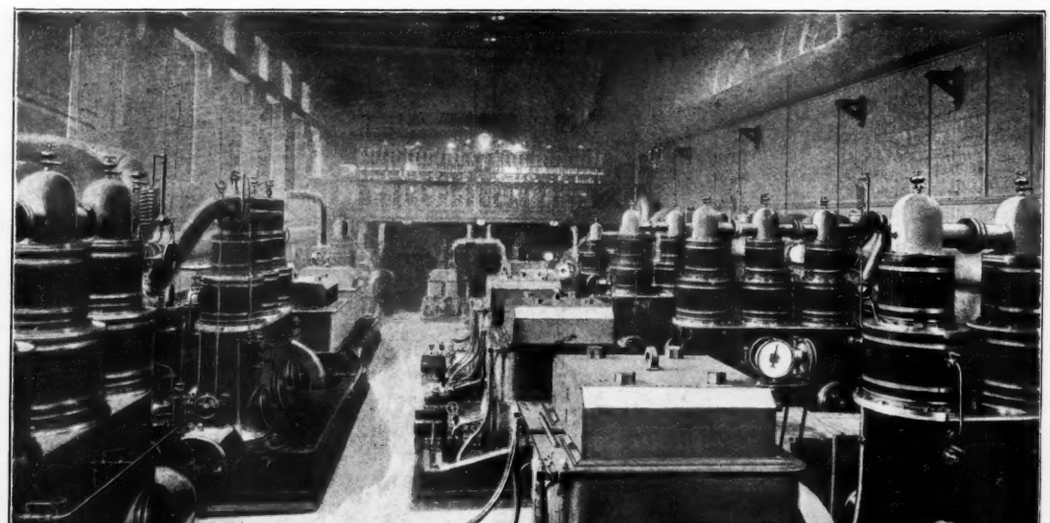
Cable Trench, with Four Feeders and Six Distributors.

We pass on now to the generating station near St. Andrew's Cross, in Pollokshaws Road. This station, which is intended to supply the area on the south side of the river, and to work in conjunction with the Port-Dundas station, is built on a site of about two acres, adjoining a siding from the Barrhead and Kilmarnock Joint Railway. The buildings were designed by Mr. Andrew Myles, to the instructions of Mr. Chamen, and were built by Messrs. J. Green & Co., chiefly of terra-cotta brick. In this case the Electricity Committee decided to erect the whole of the buildings at once, to avoid the delay in building met with in the past, and they are now practically complete; provision is made for plant of about 15,000 I.H.P.

The plan and section which we give herewith show the general arrangement of the station. The siding adjoining the boiler house is intended to accommodate a whole train of coal trucks, and there will be two electrically-driven hoists, one of which will raise the trucks one by one to the level of the coal-storage tanks, where they will be run along to the desired position and emptied, while the other hoist returns them to the ground level. The engine and boiler house are arranged on the same system as at Port-Dundas, except as regards condensing, which is not at present employed. The boilers are of the Babcock & Wilcox type, with chain grate stokers, identical with those at Port-Dundas; two are at present complete, and two more in course of erection. Large water storage tanks are situated over the boilers, and are arranged so that they may be used for cooling ponds when condensing plant is installed.



Kelvin Feeder Log.



Waterloo Street Generating Station; View of Engine Room.

The engine room is served by a 25-ton electric crane by

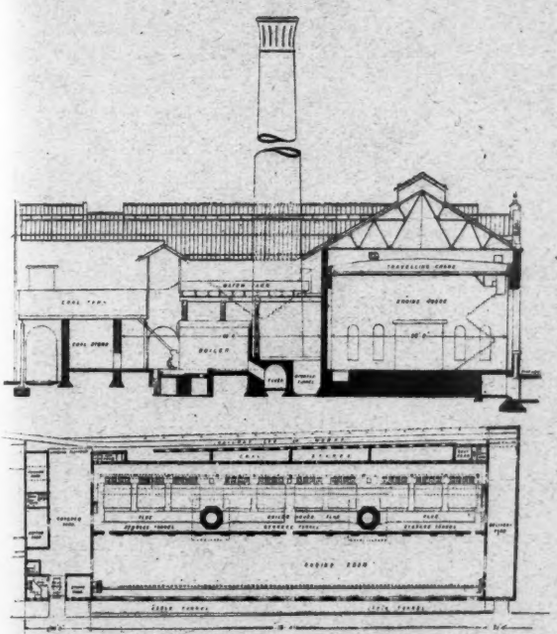
Messrs. Broadbent & Sons, similar to that at Port-Dundas.

We give a view showing the generating plant already in position, consisting of two 400-H.P. sets and one of 200 H.P. The former consist of Crompton two-pole dynamos giving 500 amperes at 510 volts, direct coupled to Belliss & Morcom three-crank tandem compound engines running at 375 revolutions per minute. The 200-H.P. set is composed of a Mavor & Coulson six-pole generator rated at 250 amperes, 510 volts, driven by a single-acting engine of the two-crank tandem triple-expansion type, running at 375 revolutions per minute, and made by Messrs. Alley and MacLellan, of Glasgow. An exactly similar set is in course of construction.

The large set which is seen partly erected in the background of our view is a 1,200—1,500-H.P. Willans-Crompton steam dynamo, identical with that which we have described in connection with the Port-Dundas station. Two more dynamos of the same size are in hand, one by Messrs. Crompton & Co., the other by the British Schuckert Company, both driven by Willans engines. These two sets will be exhibited at the Glasgow Exhibition next year.

The auxiliary plant consists of a 250-KW. balancer by Messrs. Bruce Peebles & Co., and a 125-KW. balancer by the India-rubber, Gutta-percha and Telegraph Works Company, Limited, both identical with those at Port-Dundas.

The switchboard gallery is not as yet completed, but the generator switchboards are in position; we give a view of



Pollokshaws Road Station: Plan and Section.

these, from which it will be seen that they are similar to those already described. This equipment was supplied partly by Messrs. Cowans, Limited, partly by Messrs. James White.

The batteries are to be housed in a room over the delivery yard, which, however, is not at present ready for their reception.

The delivery yard is to be used as a cable store, and is provided with a 5-ton hand traveller for the purpose of lifting the drums off the railway trucks and depositing them where required, or loading them into lorries. The engineer's offices and a range of workshops are situated at the other end of the building, and a covered yard equipped with a 7-ton traveller provides for the handling and storage of goods.

It is intended to commence the supply of electricity from this station early this month, as it is absolutely necessary for it to be running during the winter.

One of our views shows the engine room at the Waterloo Street generating station, filled to the utmost with plant; the fact that the whole of the engines in this station have a total capacity of 3,300 I.H.P.—*i.e.*, but little more than that of one of the sets in hand for Port-Dundas—shows the enormous progress that has been realised in the electric lighting of Glasgow during the last two or three years.

We give also a view of one of the cable trenches, containing four feeders and six distributors; the distributing network required for so large an area as that of Glasgow, however, is too important to be dealt with in the space at our command, and must be held over to our next issue.

(To be concluded.)

BUSINESS NOTES.

(*Continued from page* 545.)

Name Plates.—We have received from Messrs. Armstrong and Co., of 110, Cannon Street, E.C., a high-class bronze relief name plate, suitable for electrical and other machinery and switchboard work. Prices and samples will be sent upon application.

New Electrical Works.—The *Stafford Advertiser* understands that some local land agents have been negotiating for the sale to a large London firm of a considerable quantity of land at The Hough, which is required for the erection of large electrical construction works. The land the firm proposes to acquire will comprise about 50 acres. Some 700 or 800 people will be employed at the works.

Norway.—The *Steamship* says that a well-known electrical firm in Nuremburg has acquired water-power in Norway, at Sarpfoss, also that of the Glemmons, and other firms have acquired similar rights, representing in each case no less than 20,000 to 40,000 H.P., for the production of calcium carbide.

Outing.—A party of the staff of the Edison & Swan Company at Ponder's End went for their annual outing to St. Margaret's last Saturday week.

Trade Announcements.—The new address of the "Meyra" Electric Company is 78, York Road, King's Cross, N.

Messrs. Johnstone, Benjamin & Co., insulated electric wire manufacturers and metal merchants, have removed their works to Crown Electric Works, Ascham Street, Kentish Town, where all communications should be addressed. The firm have laid down an entirely new plant, replete with the latest improvements, for the manufacture of vulcanised india-rubber cables, and are now prepared to quote for highest quality goods. It is their intention, as far as possible, to keep stock of the leading sizes.

ELECTRIC LIGHT AND POWER NOTES.

Arbroath.—The Arbroath Town Council, acting under an electric lighting provisional order, have decided to invite a number of electrical engineering companies to submit a statement of terms upon which they would undertake the introduction of electrical lighting into the town. The system of supply which the Council have agreed to adopt is the "low tension three-wire system," with continuous current and 230-volt lamps, as used in Edinburgh. It is intended to put down generating plant sufficient to keep about 5,500 lamps of 8-C.P., or equivalent, burning simultaneously in addition to the public lighting, provision to be made for plant of this capacity (not less than 250 H.P.), and a battery of accumulators to take the all-night load. In regard to the public lighting the Council have, on the advice of their consulting engineers (Messrs. Buchan and Hogarth) agreed to light the principal streets by means of arc lamps. It is also proposed to have on each standard, in addition to the arc lamp, two 16 (or 25-C.P.) incandescent lamps; and that the small portion of the compulsory area not lit with arc lamps be lit by means of incandescent lamps of 16-C.P., adapted to the existing street gas lamp-posts. Messrs. Buchan and Hogarth estimate the capital outlay at £24,300, to include buildings, generating plant, mains, street lighting, meters and connections for consumers, contingencies and clerk of works, but excluding outlay for land and engineering charges. After receiving the statements or offers from companies, the Council will decide whether they will undertake the work themselves or hand it over to an electric lighting company.

Blackrock.—The U.D.C. is considering the question of undertaking the supply of electricity in the district.

Bolton.—The accounts of the electricity department for the past year show that the total expenditure on capital account during the year was £50,000, the principal items being as follows:—Purchase of land and building extensions, £11,707; Messrs. Mather & Platt, £12,062 for new engines, dynamos, &c.; Messrs. Musgrave & Sons, £6,796 for boilers, engines, &c.; mains, £9,739; and new meters, £1,762. The £50,000 was borrowed at 3¼ per cent. The income from lighting by electricity during the twelve months ending March last amounted to £9,498 as against £6,987 in the preceding year. A new item appearing in the accounts is £1,593 received

for plant of about 15,000 I.H.P.

from the Tramways Committee for electric power supplied to the cars. This was only for a period of three months, and it is expected that the sum from this source during the current year will be four times that amount. The profit on the fittings was £710, and the amount handed over out of net profits in aid of rates was £1,000, which is the same as given in the previous year.

Brighouse.—The Town Council has declared that, as the electrical supply department is overcharged with work, the engineer shall refuse all applications from new consumers.

Cardiff.—The Electric Lighting Committee of the Corporation has received a letter from Mr. W. H. Illingworth, mains superintendent, with respect to the recent shock received by himself and a wireman, and recommending certain improvements to the cable system. The letter also states that amicable relations now obtain between himself and the other officials. Some members of the committee expressed their opinion that reports should be made to the chief engineer, not to the committee, which, it was said, had interfered too much already. So it has.

Carmarthen.—The T.C. has appointed Messrs. Medhurst and Lloyd, of London, at a fee of 50 guineas to draw up a preliminary report *re* a system of electric lighting for the borough.

Croydon.—The Town Council has resolved that application be made to the Local Government Board for sanction to borrow the sum of £3,000 for the provision of arc lamps, poles, and switchgear (including extra cost of trolley poles) for the lighting of the tramway route.

Fleetwood.—Although the Fleetwood and District Electric Light and Power Syndicate, Limited, only commenced supply on February 12th, 1900, as the result of six months' summer working, the undertaking is showing a very creditable balance after paying all expenses. The system is three-wire, with 200 volts at consumers' terminals. A 2-cell Beaman & Deas refuse destructor is in combination with the boiler house plant, and for the present is capable of supplying all the steam necessary for driving the plant. The syndicate also supplies the public lamps, comprising 12 arc lamps and 500 incandescent lamps. Business has come in so rapidly, that the directors are considering the advisability of immediately increasing the plant.

Hereford.—It was reported at Tuesday's meeting of the Town Council that the cost of the town's electric light works was £20,470 16s. 2d. The demand for the current has exceeded all expectations. The present installation represents the equivalent of 6,822 8-C.P. lamps, and altogether there are over 7,500 lamps connected, while applications have been made for considerably more than 500 additional lights.

Hull.—The Electric Lighting Committee is considering complaints about fuse boxes, which are said to have an attraction for loafers, who lounge against them. A row of points round the boxes would, perhaps, discharge the electricity; at any rate, they would certainly repel the weary ones.

Leicester.—The financial statement of the electric lighting department states that the result of the working of the department for the past half-year was a net profit, after paying interest on the capital of the undertaking, of £1,430. Out of this has been paid £1,068, the half-year's amount of sinking fund, leaving a balance of £362. The revenue account shows that the expenditure amounted to £3,154, against £2,423, an increase of £731. The receipts have gone up to a greater extent than the expenditure, amounting to £6,208, against £5,040, an increase of £1,169 over the previous half-year.

The Corporation Gas and Electric Lighting Departments' South African War Fund is now to be closed. Altogether the amount raised is £322 odd, which is regarded as a very satisfactory result.

London.—Shoreditch.—The Finance Committee, at a meeting of the Vestry on Tuesday, submitted a report by Mr. H. W. Wheatley, vice-chairman, and Mr. E. A. R. Adams, the accountant, relating to the cash balance on the capital account of the electricity works. The report stated that, in accordance with instructions, those two gentlemen had waited upon the treasurer at the London City and Midland Bank with a view to the placing on deposit of a portion of the credit balance in hand on September 8th, which amounted to £30,551. It appeared that out of that sum £29,088 was in hand on the capital account of the electricity works undertaking. The deputation made an approximate forecast of the Vestry's requirements, and had arranged with the bank for the sum of £20,000, to be taken out of the electricity works capital account, being placed on deposit at 3 per cent. interest from September 13th, 1900, subject to 28 days' notice, provided that the deposit be not drawn upon below the sum of £5,000. On the recommendation of the Lighting Committee, the Vestry resolved to reinsure the electricity and destructor works for £52,000 with the Fine Art and General Insurance Company at the rate of 4s. 6d. per cent.

Bermondsey.—The Electric Lighting Committee reported, at a meeting of the Vestry on Monday, that although the time for applications for the position of resident electrical engineer had not expired, several replies had already been received. The Committee recommended that the applications should be referred to them in order to bring up a list of six names for the consideration of the Vestry at the next meeting, and this was agreed to.

Poplar.—For the first time the electric light was turned on in the Poplar streets last week. The installation, when completed, will also take in the streets of Bow and Bromley, and has been laid down at a cost of £70,000.

London, W.—A main box explosion occurred in Jermyn Street, Piccadilly, on Sunday night. The congregation were just leaving St. James's Church, and there appears to have been a general stampede. The "cheap" daily press has the usual sensational account. "Rumblings were heard as from the bowels of the earth . . . . . and all wondered what was next to happen!" There is a veiled suggestion here of calling upon the rocks to hide them.

Hampstead.—The accounts of the electric lighting undertaking for the year ending March 25th last show that the total capital outlay amounted to £162,212, an increase of £36,802 during the year. The total working costs amounted to £14,336, an increase of 26 per cent; of this coal accounts for more than half, this item having increased nearly 50 per cent. The total receipts were £30,661, again showing an increase of 26 per cent. The average revenue per 8-C.P. lamp connected works out at 6s. 2d. per annum. The number of 8-C.P. lamps connected is 104,579, having increased by 21,907, and the highest output in one week was 63,441 units. Repayments of loans, with interest, absorbed £6,619 of the gross profit of £16,325; other expenses brought down the net profit to £9,357, representing a dividend on capital of 8·23 per cent. The total net profit since the commencement of supply amounts to £19,426, of which £16,221 has been carried to reserve, and £3,205 allotted for the formation of a sinking fund.

Hackney.—The foundation stone of the new electric lighting and dust destructor works at Hackney will be laid on 18th inst. Mr. W. H. Dickinson, the chairman of the London County Council, will perform the ceremony.

Battersea.—The Vestry intends to make application to the Local Government Board for leave to borrow £10,096 for extensions of the electric lighting mains.

Macclesfield.—The Town Council has decided to apply for a provisional order for electricity supply.

Mountain Ash.—The District Council has decided to apply to the Board of Trade for a provisional order empowering it to supply electricity in the district.

Nelson.—On Thursday Mr. M. R. North, M.I.C.E., conducted a Local Government Board inquiry at Nelson with regard to the Corporation's application for sanction to borrow £2,500, to provide an extension of the present storage battery by the addition of 72 cells. There was no opposition.

North Metropolitan District.—A conference of local authorities was held at Tottenham on Wednesday last week. The promotion of the Bill in Parliament to confer powers for the supply of electric light and power, and the proposals to distribute as well as generate electricity, were accepted.

Mr. Offor, representing the North Metropolitan Electrical Power Distribution Company, Limited, submitted a draft agreement to the Enfield Urban District Council, embodying the proposals of his company. Mr. Offor attended a meeting of the Council, and the agreement was gone through clause by clause. It was eventually agreed that Mr. Offor should take back the agreement for the purpose of embodying such of the proposals made by the Committee as were acceptable to his company, and return the amended draft.

Norton (Malton).—At a meeting of the Urban District Council last week it was resolved conditionally to consent to an application to the Board of Trade by the Northern Counties Electricity Supply Association for an order enabling them to supply electricity for the lighting of Norton. The association agrees to light the whole of the present area of the district for 30 per cent. less than the price paid for gas, and to charge private consumers not more than 7d. per unit.

Poplar.—The electricity works of the Board of Works are to be opened on Monday afternoon next, October 8th.

Rhondda Valley.—The Legal Committee of the District Council have recommended that Mr. Hammond be retained as electrical expert for their electric scheme, the fee being 50 guineas and travelling expenses, and 3 guineas per hour as Parliamentary fees whenever required to meet the Committee. But the Council thought the terms high, and decided to ascertain the terms of Mr. Coulson, gas engineer to the Leicester Corporation.

Sidcup.—At a ratepayers' meeting last week a resolution was passed to support an application for a provisional order authorising the supply of electricity in the district by the local authority.

Staines.—The U.D.C. has decided not to take over the Staines part of the Staines, Egham and Chertsey electric lighting order.

West Bromwich.—The E. L. Committee of the T.C. have recommended the Council that the charge for electricity for lighting purposes be at the rate of 6d. per unit for the first 100 hours' use of the maximum demand in each quarter, and thereafter, during the same term, at the rate of 2d. per unit. For power purposes the charge is to be at the rate of 3d. per unit for the first 78 hours' use of the maximum demand, and thereafter at the rate of 1d. per unit. They further recommend that the "free wiring system" be adopted, and that application be made to the Local Government Board for sanction to borrow £10,000 for providing materials and labour for wiring houses, and also for the purchase and fixing of motors, which they have resolved to hire out for power purposes. A further large demand for power has been made upon them, to meet which the engine house must be enlarged. If this is done while the building is in course of erection, a considerable saving will be effected.

a total capacity of 3,300 I.H.P.—*i.e.*, but little more than

year. A new item appearing in the accounts is £1,593 received

York.—According to the Electric Lighting Committee's report the result of six months' working has been a trading profit of about £250. It is hoped that a very satisfactory profit will be shown at the end of 12 months.

ELECTRIC TRACTION NOTES.

Aberdeen.—In consequence of a recent electric car fatality, safety fenders are being purchased for the cars.

Ashton-under-Lyne.—In the political news we read that Mr. Herbert Whiteley, the Conservative candidate, stated in one of his speeches that as a result of his representations, without prejudice to the merits of the dispute on either side, the chairman of the Oldham, Ashton, and Hyde Electric Tramway Company would probably agree to reinstate their drivers and other employés who were on strike, the understanding being that alleged grievances would be further discussed with a view to amicable settlement.

Cardiff.—The Tramways Committee on Friday approved plans for the new electrical power station on the Newport Road site near Roath Brook, submitted by Mr. Ellis, the electrical tramway engineer. The engineer was instructed to proceed with the excavations for the concrete foundations. It was mentioned incidentally that precautions would be taken to prevent flooding.

Carnarvon.—A sub-committee of the Joint Committee of the Gwyrfai D. C. and the Carnarvon T. C. has recommended that the scheme promoted by Mr. Peterson's syndicate for the construction of a light railway from Carnarvon to Dinas Dinlle, and electricity works, be assisted in every possible way under reasonable conditions.

Central London Railway.—We read that to meet the great rush of traffic, the three-and-a-half-minute service of trains has now been altered to a two-and-a-half-minute service.

Darwen.—The electric trams are stated to be ready for Board of Trade inspection.

Dundee.—The Lochee Road electric tram route is ready for Board of Trade inspection.

Glasgow.—As stated last week, the buildings in connection with the power station for the new electric tramway system at Pinkston, Port Dundas, being somewhat behind, the Corporation have decided to finish the buildings themselves. The original contract amounted to £50,000, but the contractors will only receive a proportionate allowance for the parts they have finished, viz., the foundations and part of the lower walls. The Corporation will employ men under the tramway department to complete the work. It may be of interest to mention that the successful contractors were the second lowest when tenders were opened. The lowest were offered the work, but declined to complete in a guaranteed time under a penalty. A mechanical engineer has now been appointed at a salary of £250 per annum to take charge of the steam plant at this new station. The drawings for the week ending 22nd ult., amounted to £9,813 11s. 3d. as compared with £8,971 16s. 5d. for the corresponding week last year.

At a meeting of the Tramways Committee this week it was agreed that next session the Corporation should obtain Parliamentary powers to extend the electric tramway system to Clydebank—a distance of seven miles from the Royal Exchange; Bishopbriggs, a distance of about six miles from the same place; Rutherglen and Cambuslang, a distance of about eight miles, and also along the Cumbernauld Road, past the Alexandra Park and the Provan Gasworks, another distance of about five miles from the Royal Exchange. In nearly every case the present trams run about halfway to all the above places, but owing to the rapid growth of the city in these directions the population on the outskirts and suburbs have a considerable distance to walk to the nearest tram terminus. In all, the total new mileage for which powers will be sought will amount in the aggregate to some 10 miles of double line or 20 miles single track.

Great Yarmouth.—It is stated that the municipal electric tramways will shortly be completed.

Maidstone and Faversham.—The Light Railway Commissioners have submitted the Maidstone and Faversham Junction Light Railways Order to the Board of Trade for confirmation.

Netherton, Sedgley, &c.—The electric tramways in the Cradley Heath, Old Hill, Netherton, Upper Gomal and Sedgley districts have been at length opened for traffic. Colonel Trotter, as has been stated in the Electrical Review, inspected the electrical equipment and the lines some six weeks ago; and on Friday last Colonel Dunlop, on behalf of the Board of Trade, inspected the new tramway from Dudley to Cradley *viâ* Netherton, and the reconstructed line from Dudley to the tramway depôt at Sedgley, both of which, within the borough, will be supplied with electricity from the Dudley Corporation generating station.

Northampton.—The Electric Light and Tramways Committee recommend the Town Council to take steps to obtain Parliamentary powers to work the tramways when obtained.

St. Helens.—The Electric Supply and Tramways Committee has instructed the town clerk to include in the application to the Board of Trade the sums required for the construction of the tramways from Derbyshire Hill to the borough boundary in Newton Road; and from Station Road to the borough boundary in Bold Road. The borough engineer and borough electrical engineer were instructed to prepare estimates of the cost. The borough electrical engineer reported that the period of maintenance by the contractors of the overhead equipment on the Prescot and Denton's Green sections had expired on August 21st; that the equipment had been maintained in a satisfactory manner, and that it had been taken over by the Corporation on the day named.

Southend-on-Sea.—Active operations have commenced in connection with the electric tram scheme of the Corporation.

Wolverhampton.—At a meeting of the Tramways Committee of the Corporation last week, the members again considered the question of reconstructing and electrically equipping the section of the tramways which runs from the Bilston Road terminus to Newbridge, Tettenhall, and after much discussion it was decided to advertise for tenders for the necessary material required for the work.

TELEGRAPH AND TELEPHONE NOTES.

Glasgow Telephones.—Permission was granted on Monday by the Corporation for the Committee on Telephones to open up the streets in the area bounded on the south by the River, on the west by Hope Street, along George Street and down High Street to the River again. The Corporation hoped the Committee would do their utmost to hurry forward the laying of the mains, and that they would disturb the public streets as little as possible.

Government and the Eastern Telegraphs.—We reproduce the following comments on an interesting matter from the *Pall Mall Gazette*:—"'Doubtless a time will come when all our main cables of the first importance will be in the hands of the Government, when they will only touch on British territory, and when they will be adequately protected from an enemy.' These words were spoken by Sir George Robertson at the meeting of the British Association at Bradford, and they may be the means of hastening the acquisition by the Government of the principal submarine cables, more especially those connecting with the East and with Africa. Nor would there appear to be any insuperable obstacles in the way, for the chief lines belong to English companies, which, for all practical purposes, are controlled by the same directors, the Marquis of Tweeddale and Mr. John Denison Pender being connected with the two Eastern lines and with two of the three African lines. Connecting England with the East there are the Eastern Telegraph Company, whose cables run through the Mediterranean to Eastern Europe, and the Eastern Extension, which continues on to Australia, India, China, and Japan; and besides these there are the Indo-European, which is principally a land-line, and is controlled by a mixed board of directors, English and German, with an official Russian representative, and the Great Northern, which belongs to a Danish company. Running to South Africa there are three cables, owned by the Eastern and South African Company, the West African Company, and the African Direct Company, all of which are practically subsidiary companies of the Eastern and Eastern Extension, the whole forming a compact group. Coming to the money part of the question, there need be no more difficulty than was experienced when the Government bought the home telegraph companies, the terms of payment being settled by arbitration based upon certain agreements come to between the contracting parties. The whole capital involved in the two big Eastern companies, for it would hardly be thought necessary to deal with those under foreign control, since no monopoly is aimed at, and the three African companies, is £12,529,288, namely, the Eastern, £7,262,098; Eastern Extension, £2,853,300; Eastern and South African, £1,650,090; West African, £416,990; and the African Direct, £346,900. This, however, is the nominal capital only, the market value being somewhat more, the ordinary stocks of the two Eastern companies standing at a premium of about 50 per cent.; so that a sum of about £16,040,000 would represent the actual aggregate value of the five companies, and it is upon this basis that the purchase money would have to be calculated. When the Government purchased the home telegraphs the cost was about 10 millions, but some fanciful prices were given, in some cases the aggregate value of the stock calculated at the highest market price during a certain period, plus 20 years' net income; but it is not to be supposed that such terms would be entertained as exacted in the event of a purchase of the submarine cables, but of course there would necessarily be an allowance for disturbance, seeing that the income of the company is steadily growing, and will probably grow faster as our interests in the East and in Africa expand. Under any circumstances, however, probably the total sum required would not exceed 18 millions, and if this were raised at 3 per cent. the transactions would yield a good profit to the Government, for at present the Eastern and Eastern Extension alone are earning over £1,066,000 net profit per annum, what the African companies are earning being an unknown quantity, as they do not publish any accounts. There will, therefore appear to be no points of difficulty in the matter, and, as in the case of water companies, delay would mean the payment of a larger amount. It is hardly necessary to

at a cost of £70,000.

this is done while the building is in course of erection, a considerable saving will be effected.

deal with the Western lines, because our interests are neither so great nor so complicated in that direction, but here also is a direct English cable running from Valentia to Newfoundland, owned by a British company, the Anglo-American, with which arrangements for purchase could, no doubt, be made. This matter does not press as does the Eastern route, and may therefore be left alone for the present, with the remark that the nominal capital of the Anglo-American is £7,000,000, having a market value of £4,527,000."

London and Brussels Telephones.—The *Daily Chronicle* says that it is announced that direct telephonic communication will be established between London and Brussels at the beginning of next year at a charge of 10 francs for three minutes' conversation.

The *Times* says that some very successful experiments have been made with the Brussels-London telephone. Conversations have been conducted with great distinctness, not only between Brussels and London, but between Brussels and Manchester and towns in North England, a distance of about 500 miles. The charge for five minutes' conversation between London and Brussels will, it is stated, be 4s. The cable crosses the Channel between the Belgian coast, near Ostend, and St. Margaret's Bay, near Dover. The cable contains four wires, and runs 60 miles under sea.

We are in a position to be able to say that the statement by the *Times* is altogether incorrect; no such experiments have been made; the 60-mile cable referred to does not yet exist, except in imagination.

National Telephone Company v. De Pass & Co.—In the City of London Court on Tuesday, says the *Times*, before Mr. Commissioner Kerr, an action was brought by the National Telephone Company, Limited, to recover the sum of £50 for the use of a private telephone wire supplied to the defendants, Messrs. Daniel de Pass & Co., Fenchurch Buildings, E.C., from their City office to their branch establishment at Barking. The defendants declined to pay because the wire had never been efficiently fixed: when they used it they heard voices in the exchange, although it was supposed to be a private telephone. The plaintiffs, on the other hand, declared that the wire had been fixed as well as possible. The difficulties to be contended with in carrying the telephone service to Barking were very great. For four miles the wires had to stretch alongside the sewer bank, where the inhabitants of Barking relieved the monotony of their existence by throwing disused kettles, old pails, and other missiles at the wires. Those articles weighed down the lines and interrupted the service. On several occasions whole lengths of wire had been cut off and taken away. Of course the police were communicated with, but with no result. The company did not guarantee that the telephones would work always. They only did their best in the matter, and they could not do more. The defendants said they wanted the private wire very badly, but they repudiated their liability under the contract, which was for five years, as the wire had never worked efficiently. The jury found for the defendants. Mr. Lewis Glyn, the defendants' counsel, said they were willing, before the trial, to pay the plaintiffs £25, without costs, but the company were so pig-headed they would agree to nothing.

Telegraphic Interruptions and Repairs:—

Cables.	Interrupted.	Repaired.
South American:—		
Pará-Maranham	March 1, 1900	
Ceará-Maranham	Feb. 20, 1900	
Direct Cable Pernambuco-Para	Sept. 19, 1900	Sept. 28, 1900
West Indies:—		
Mole St. Nicholas-Cape Haitien	March 6, 1900	
Latakia-Cyprus	June 20, 1899	
St. Louis (Senegal)-Bathurst	Aug. 25, 1900	
Tarifa-Tangier	Jan. 2, 1900	
Zanzibar-Mombassa	Sept. 29, 1900	
Landlines:—		
Chinese:—		
Tientsin-Pekin	June 13, 1900	
Pekin-Kalgan	June 14, 1900	
Kalgan-Maimatchin	June 30, 1900	
Tientsin, *via* Shanghai	June 16, 1900	
Tientsin-Niuchwang	June 18, 1900	
South American:—		
Communications with all offices of Columbia beyond Buenaventura	January 22, 1900	
Ecuador landlines	March 18, 1897	
Landlines south of Serena	July 30, 1900	
Communication "*via* Hanekine" interrupted on Persian territory	Feb. 24, 1900	
Saigon-Bangkok	Oct. 2, 1900	Oct. 3, 1900

Trans-African Telegraphs.—A Reuter dispatch from Karonga, dated June 19th, stated that the African Trans-Continental telegraph line is completed to Kituta on the south end of Lake Tanganyika, and is expected to be carried by the end of July across the Anglo-German frontier to Kassanga, the German station north of Kituta.

CONTRACTS OPEN AND CLOSED.

OPEN.

Aberdeen.—October 17th. The Tramways Committee wants tenders for 25 electric tramcars, and electrical equipments for six horse cars. See "Official Notices" September 21st.

Belgium.—October 10th. Tenders are being invited until October 10th by the Belgian State Railway authorities at La Bourse, Brussels, for the supply of 20,000 porcelain insulators for telegraph lines, 65,000 ditto for telephone lines, 15 tons of galvanised iron wire 3 mm. diameter, and 60 tons ditto 4 mm. diameter.

Bermondsey.—October 15th. The Vestry wants tenders for steam and other piping, feed pumps, tank and ironwork; also steam dynamos, battery charging motor booster and balancer. See "Official Notices" September 28th.

Bootle.—October 13th. The Corporation wants tenders for a steam dynamo. See "Official Notices" September 28th.

Bradford.—October 9th. The Corporation wants tenders for an engine and dynamo and switchboard apparatus, &c., for its destructor works. See "Official Notices" September 21st.

Budapest.—October 15th. The Hungarian Minister of Commerce is prepared to receive tenders for the installation of two telephone exchanges, local and interurban, complete in all respects. See "Official Notices" August 3rd.

Bulgaria.—October 15th. The municipal authorities of Varna are inviting tenders until October 15th for the concession for the electric lighting of the town during a period of 40 years.

Bulgaria.—October 22nd. Tenders are invited by the Municipality of Philippopolis for a concession for electric lighting and a tramway in that town.

Cardiff.—October 23rd.—The Corporation wants tenders for slow speed vertical engines and generators; boilers, economisers, &c., for electric tramways. See "Official Notices" to-day.

Cuba.—October 26th. The municipality of Cienfuegos is inviting tenders for a service of public electric lighting for the town. All inquiries and tenders to be sent to the Secretary's Office in Cienfuegos, Cuba.

Dartford.—The Urban District Council is inviting tenders for the erection of an electric lighting station.

Dundee.—October 15th. The Gas Commissioners want tenders for the supply and erection of three steel water tanks at the electric lighting station. Form of tender, &c., may be had on application to Walter H. Tittensor, city electrical engineer, Dudhope Cresent Road, on deposit of £1 1s.

Glasgow.—October 13th. The Corporation wants tenders for cables for connecting up plant, also for transformers connecting bars, at the Pinkston power station. See "Official Notices" to-day.

Great Western Railway.—October 22nd. Tenders are required for the supply of stores (from December 1st, 1900, to November 30th, 1901), including telegraph poles, apparatus and accessories, electric light carbons, lamps, &c. See "Official Notices" to-day.

Grimsby.—October 6th. The Corporation wants tenders for wiring the free library. See "Official Notices" September 21st.

Grimsby.—October 6th. The Corporation wants tenders for the wiring of the Free Library.

Ilford.—October 8th. The Council wants tenders for direct current meters and cut-outs. See "Official Notices" September 21st.

India.—October 16th. The Secretary of State for India in Council is prepared to receive tenders from such persons as may be willing to supply (1) a complete electrical installation for supplying power to a factory from a waterfall (about 3 miles distant from factory). The generator will be required to develop about 500 KW., and the installation is to include complete plant of generators line, transformers, cables, motors, &c. (2) a complete hydraulic installation required to develop about 500 H.P. from a waterfall approximately 620 feet high. The conditions of contract may be obtained on application to the Director-General of Stores, India Office, Whitehall, S.W., and tenders are to be delivered at that office on Tuesday, October 16th, 1900, after which time no tender will be received. (E. Grant Burls, Director-General of Stores.)

London.—November 10th. The Streets Committee of the Corporation wants to hire a mechanically driven dust cart. See "Official Notices" to-day.

Maidstone.—October 16th. The Corporation wants tenders for surface condenser and feed pumps. See "Official Notices" September 28th.

Sheffield.—October 6th. The Corporation wants tenders for two two-phase steam alternators and exciters of 600 KW. each, and the alteration of present single-phase plant to two-phase plant. See "Official Notices" September 14th.

Spain.—October 11th. The *Madrid Gazette* publishes a notification of the conditions on which a contract for the electric lighting of the town of Azuaga will be awarded. Tenders will be received by the municipality up to 11th prox., the upset price being 9,000 pesetas annually for electric lights of 3,000 C.P., distributed in incandescent lamps of 10 and 16 C.P.

Stavanger.—January 2nd. Tenders are invited by the Stavanger Corporation for the establishment of electrical communication or transmission of power from the Altesrig Waterfalls to Stavanger, a distance of about 39 kilometres, in accordance with the plans of a civil engineer named Schoien. Tenders must be received by January 2nd, 1901. Further information may be obtained on application direct to Mr. E. Berentsen, British Vice-Consul, Stavanger.

Parliamentary powers to work the tramways when obtained.

mean the payment of a larger amount. It is hardly necessary to

Suffolk.—October 5th. The Visiting Committee of the County Lunatic Asylum wants tenders for the wiring and fitting of the County Asylum at Melton for electric lighting. See "Official Notices" September 14th.

Sunderland.—October 15th. The Corporation wants tenders for 24 car bodies, trucks, and electrical equipments. See "Official Notices" September 28th.

Swansea.—October 10th. The Corporation wants tenders for cast-iron arc and incandescent lamp standards, arc lamps, automatic switches and other fittings. See "Official Notices" September 28th.

Warrington.—The Corporation wants tenders for the installation of electric light mains and fittings into the electric station and central sanitary depôt. See "Official Notices" September 28th.

Whitechapel.—October 23rd. The Board of Works wants tenders for an overhead traveller (hand driven) for the electricity works. See "Official Notices" to-day.

Whitehaven.—October 13th. Tenders are wanted for the supply and erection of a switchboard at their electric lighting station. See "Official Notices" September 14th.

CLOSED.

Grays.—The Urban Council, on the advice of Mr. Preece, the electrical engineer, has accepted the following tenders:—

Boilers—Messrs. Danks	£2,325 0
Steam Dynamos—British Schuckert Company ..	2,147 10
Economiser—Messrs. Green	241 10
Switchboards—General Electric Company	628 15
Battery—D.P. Battery Company	836 1
Crane—Messrs. Carrick & Ritchie	95 10
Cables—Messrs. Callender	3,545 0

A tender for a dust destructor building at £850 was also accepted.

Kingston.—The Lighting Committee has accepted the tender of Messrs. F. & H. F. Higgs for extensions at the municipal electric works at £2,330.

Rochdale.—The Guardians have accepted the tender of the Edison & Swan United Electric Light Company, (Manchester), for 3,000 yards of tubing, and 6,000 yards of wire, for the electric lighting of the new infirmary.

Worthing. — The Electric Lighting Committee have accepted the following tenders for the supply and erection of the necessary plant in connection with their electric lighting installation:—

Dynamos—Messrs. Scott & Mountain	£2,850
Boilers, &c.—Messrs. Danks & Co.	1,120
Manhole covers—Callender's Cable and Construction Co.	501
Arc lamp posts—Messrs. Mackenzie Bros.	1,333
Stoneware casings—The Albion Clay Company	2,102
Cable Work—Callender's Cable and Construction Co. ..	5,967
Storage batteries—Eclipse Brass and Copper Co., of York	984
Boosters, &c.—Messrs. Laurence, Scott & Co.	710
Economiser—Messrs. Lowcock, Limited	372
Travelling Crane—Messrs. Carrick & Ritchie	165

With reference to the erection of the generating station and the alterations to the existing building on the site, there was a marked difference between the lowest tender received and the architect's original estimate of the cost, and at a meeting in committee the Council decided not to accept either of the tenders, but to carry out the works under the supervision of the borough surveyor.

NOTES.

Electric Traction on Canals.—The Société de Traction Electrique Sur Voies Navigables has undertaken the installation of a system of traction over a water-course of 76 km., extending from Béthune to the Scheldt; the boats used are Flemish sloops of 270 to 300 tons burden, with a draught of 1·80 metres. This navigable water-course is interrupted by six locks. The price of steam or horse traction is ·0045 franc per ton-kilometre; for the electrical installation, this tariff is reduced to ·003 franc. The section in service at present is 26 kilometres long; it is fed by two stations situated 11 kilometres apart, and of a total power of 400 H.P. The continuous current at 500 volts is produced by 8 generators of 30 kilowatts. The overhead conductors are suspended from posts 40 metres apart at a height of 6·50 metres above the tow path. The tractive power consists of 30 Galliot electric tractors; each tractor, weighing 2 tons, is mounted on four wheels of ·8 metre, two of which only are drivers. The length of the tractors is 4·25 metres, and their breadth 1·45 metres. The electric tractor easily draws one or two boats of 300 tons at the rate of 3 km. per hour.—*L'Electricien.*

Electric Trams at the Lakes.—The following important letter in the *Times* from the pen of Mr. Emile Garcke will be read with interest by those who followed the controversy regarding the Lakes electric tram scheme:—

Sir,—We did not think it was necessary to reply to the letter which appeared in your issue of the 11th inst. from Mr. Rawnsley, the hon. secretary of the "National Trust for Places of Historic Interest or Natural Beauty;" but as our silence, coupled with the fact that we have withdrawn our present application for a light railway order, has been misinterpreted as a concurrence with the statements made by Mr. Rawnsley, I shall esteem it a favour if you will allow me to make a few corrections.

We have withdrawn our application for an order because, although the scheme was approved in principle by some of the authorities, several alterations in the proposed routes were desired by them, and could not be carried out by any modification of the order applied for, and it is necessary to apply for a new order if effect is to be given to the wishes of the local authorities in regard to the routes and other similar matters.

Then, with regard to the alleged spoliation of the beauties of the district, we do not admit that this allegation has any solid foundation. We should be bad men of business if we proposed a scheme involving an expenditure of much capital, if we were not satisfied that such scheme would be popular, not only with the people of the district, but with the numerous visitors.

We quite appreciate that some people dislike not only electrical tramways, but also railways, and that the few who have been able to select one of the prettiest districts in the kingdom for their residences may desire to maintain their seclusion; but that is no reason why the much larger number of people who are unable to afford to pay the heavy fares charged by the coaches in the district, and who are much less able to reside in the district, should be excluded from it. It must not be forgotten that the lake district does not belong to the few who reside in it, and the argument that electrical tramways would spoil the district for every one is quite inconsistent with the other argument, that the tramways will bring a large number of people into the district.

There is no difficulty whatever in quoting a considerable number of places on the Continent and in America, containing equally beautiful features as the English lake district, where the view prevails that not only should the beauties of the district be brought within reach of as many as possible, but that the introduction of electrical tramways appreciates the value of the property and the attractions of the district.

I am, Sir, your obedient servant,

E. Garcke, *Managing Director*,

The British Electric Traction Company, Limited.

September 22nd.

Electric Lighting Provisional Orders.—A statutory return just issued shows that applications made to the Board of Trade last year under the Electric Lighting Acts of 1882 to 1890 numbered 111, the largest in any year except 1890 and 1883, when the totals were 166 and 116 respectively. There were 109 orders asked for in 1899 and in response the Board made 90, all of which, save one, were confirmed by Parliament. Two licenses were also applied for and granted. The orders applied for since 1882 amount to 753, of which 430, allowing for those subsequently revoked or repealed, now stand confirmed. Of 48 licenses asked for only three remain in force at the present time. The growth, says a financial daily, in the number of orders alone, however, is ample testimony of the development of the electric lighting industry and a secure promise of its prosperity in the future. Of the applications for orders 59 were made by local authorities and 49 by 27 companies or persons. Six orders affected the County of London. Three asked for by the local authorities were granted; two made by companies and opposed by the authorities were also granted, and one made by a company and opposed by the authorities was rejected.

The Pan-American Exposition.—The progress that has so far been made in erecting the buildings of the forthcoming Pan-American Exposition to be held near Niagara Falls is very pleasing to those who have the affairs of the great exposition in charge. The Electricity Building is to be 500 by 150 feet, and in it there will be 75,000 square feet of exhibition space available. It will be devoted to three groups of exhibits, namely, the service plant for the transformation and distribution of the 5,000 H.P. to be transmitted from Niagara Falls for lighting and power purposes; a collective exhibit of historical interest, containing illustrative models and apparatus showing important advances in the art; the commercial exhibit, showing articles possessing distinctive merit, either in workmanship, novelty or usefulness.

Bourse, Brussels, for the supply of 20,000 porcelain insulators for telegraph lines, 65,000 ditto for telephone lines, 15 tons of

obtained on application direct to Mr. E. Berentsen, British Vice-Consul, Stavanger.

Left Behind in One Thing.—A Consular report on the trade and finances of Mexico has just been issued from the Foreign Office. Among many other matters, it is stated that the use of electricity for lighting, traction and power, is rapidly on the increase. The *Financial Times* quotes:—"Already nearly every town in the Republic is lit by electricity, a statement which may well cause surprise when so little progress has been made in this direction in Great Britain, and it is also matter for regret that the exports from this country to Mexico of electrical apparatus are on an exceedingly small scale. Out of £9,000 worth of electric batteries imported into the Republic in 1899, only £409 worth came from England, and of electric incandescent lamps, to the value of £16,000 imported, nearly the whole were supplied by the United States and Germany. But it is not only in electrical appliances that we are being left behind."

Utilising the Energy Lost in Resistances.—In a recent issue of the *Elektrotechnischer Anzeiger* an anonymous writer suggests utilising the energy lost in auxiliary resistances, such as those used for regulating the speed of motors, steadying arc lamps, &c. For instance, the resistance for regulating the speed of a fan motor may be switched in for quite a while, while the fan motor is running at less than full speed. In this case he suggests the use as auxiliary resistance of a low-voltage incandescent lamp placed in a room not too far away from the motor. At its side he suggests placing another lamp to be supplied with current direct from the supply mains, and arranging the connections so that as soon as the resistance lamp of the motor is switched out the other lamp is automatically switched in, the circuits being such that the two lamps cannot be lighted at the same time.—*American Electrician.*

Personal.—On Friday evening last the employés at the Woking Electricity Works presented Mr. A. J. Wheatley, engineer and works manager, with a silver cigarette case, suitably inscribed, together with an illuminated address, as a small token of their esteem and respect for him, on the occasion of his leaving Woking.

Mr. R. L. Acland, who has recently been appointed electrical engineer to the Corporation of Chesterfield, has now taken up his duties in that town.

Prof. Alex. B. W. Kennedy informs us that the style of his firm will be henceforth Kennedy & Jenkin. All future communications should be addressed to the firm in this manner at 17, Victoria Street, S.W.

Appointments Vacant.—A shift engineer at £2 per week is wanted for the Blackburn electricity works. Two assistant engineers at £120 per annum, are required for the West Hartlepool electricity works; and a borough electrical engineer at £250 per annum is called for at West Bromwich.

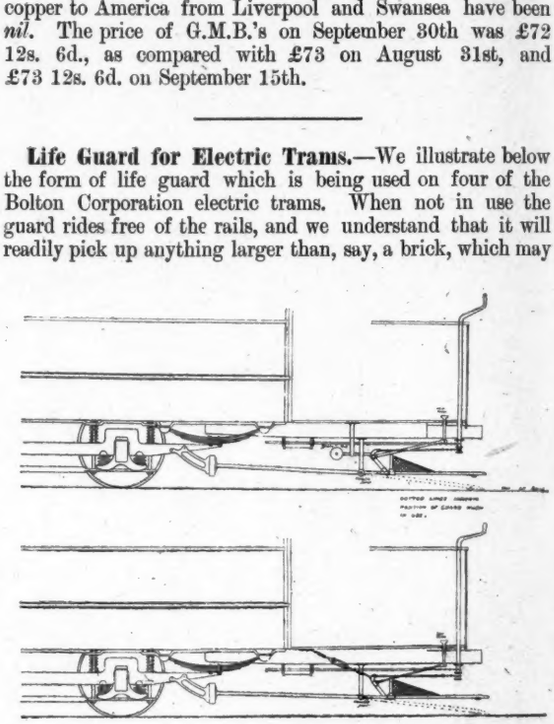
A mains superintendent is wanted at Southampton at £150 per annum. The Poplar Board of Works require an accountant and chief clerk for the electricity works at £150 per annum. See our "Official Notices."

Lectures.—Prof. Thompson's course of lectures on "Polarisation of Light" commences on Friday, October 12th, at the Finsbury Technical College. A course by Mr. E. Rousseau on "Electro-deposition" commences on Wednesday, 10th inst. See our advertisement pages for details.

Fatality.—On Wednesday last week a fitter named Haines was engaged with another man in placing in position a fly-wheel and shaft at the Manchester Corporation electric light works in Dickinson Street. Haines went into the crank pit into which the shaft had to be lowered, and whilst he was there the packing on which the machinery was resting gave way, causing the shaft to move and pin him. When he was extricated it was seen that he had been seriously injured. He died before reaching the Manchester Infirmary. At the inquest the verdict was "Accidental death."

The Copper Market.—The last issue of Messrs. H. R. Merton & Co.'s statistical circular shows that stocks have fallen by 1,042 tons during the month, while prices have also declined 7s. 6d. per ton. The shipments from North America have amounted to only 9,858 tons, as compared with 16,845 tons in August, and 18,289 tons in April. During the seven months ending August 31st, 1900, 106,679 tons of copper were shipped from North American ports to Europe. This represents a monthly average of 15,240 tons. The supplies from Spain and Portugal, from Chili and from Australia in September, have been about the average, while those from the outside countries show a slight falling off, being 3,113 tons, as compared with a monthly average of 4,000 tons for the preceding 12 months. The total supplied in September reached 19,521 tons, and the total deliveries 20,563 tons. The shipments of "Standard" copper to America from Liverpool and Swansea have been *nil*. The price of G.M.B.'s on September 30th was £72 12s. 6d., as compared with £73 on August 31st, and £73 12s. 6d. on September 15th.

Life Guard for Electric Trams.—We illustrate below the form of life guard which is being used on four of the Bolton Corporation electric trams. When not in use the guard rides free of the rails, and we understand that it will readily pick up anything larger than, say, a brick, which may



be on the track; in fact, it has already saved a couple of stray sheep, not hurting them in the least. The guard is the invention of Mr. Arthur Hudson, chief motor inspector in connection with the Corporation trams. It is being made by Messrs. Horsfall, Heathcote & Co., at their Bradshawgate Engineering Works, Bolton.

The Electro-Harmonic Society.—The fifteenth season of this society will be opened on Friday next week, 12th inst., with a smoking concert, to be presided over by Mr. J. Wilson Swan, F.R.S. The society has returned to its old meeting place, viz., St. James's Hall Restaurant. We would add that the society extends a very cordial invitation to engineers to become members. Applications for particulars should be addressed to Mr. C. E. Grove, the hon. sec., "Rosedale," Selsdon Road, Wanstead, Essex.

Marriages.—On September 5th, at Glasgow, Mr. D. Martin, A.M.I.E.E., of Messrs. Mechan & Sons, was married to Miss Margaret M. T. McFie, youngest daughter of Robt. McFie, Esq., engineer, Glasgow. From the foremen of Scotstown Iron Works and the men of the electrical department, Mr. Martin received two handsome presents.

On Thursday last week Mr. Bertram Thomas, the present proprietor of the Cornbrook Telegraph Works, in Manchester, and who has been for a great number of years engaged in telegraph and other electrical work, was married to Miss Ethel Benham, daughter of the late John Benham, Esq., of Clapham Park.

per hour.—*L'Electricien.*

NEW COMPANIES REGISTERED.

General Electric Company (1,900), Limited (67,307).—This company was registered on September 27th, with a capital of £800,000 in £10 shares, to acquire the business of the General Electric Company, Limited (incorporated in 1889), and to carry on the business of electricians, electrical and general engineers, ironmongers, makers of electrical tramcars, motor cars, carriages, cycles and vehicles, dynamo and motor manufacturers, makers of telephones, bells, electroliers, arc and other lamps, electric light fittings, india-rubber, asbestos and other insulating materials, chemical and other apparatus and all electrical accessories and appliances, &c. The first subscribers (each with one share) are:—G. Byng, 71, Queen Victoria Street, electrical engineer; M. Byng, 71, Queen Victoria Street, E.C., electrical engineer; H. Hirst, 71, Queen Victoria Street, E.C., electrical engineer; A. Eckstein, Peel Works, Adelphi, Salford, electrical engineer; W. White, 71, Queen Victoria Street, E.C., electrical engineer; E. Wilson, 71, Queen Victoria Street, E.C., clerk; and T. J. K. Alwood, 71, Queen Victoria Street, E.C., accountant. The number of directors is not to be less than three nor more than nine. The first four names are the first directors; qualification, £1,000; remuneration as fixed by the company. Registered office, 71, Queen Victoria Street, E.C.

Sussmann Electric Miners' Lamp Company, Limited (67,293).—This company was registered on September 26th, with a capital of £30,000 in £1 shares, to acquire the business of the Sussmann Electric Miners' Lamp Company, Limited, to adopt an agreement with the said old company and its liquidator, and to carry on the business of manufacturers of and dealers in galvanic batteries, miners' and other lamps, electrical apparatus, telegraphs, telephones, electro-motors, insulators, and all chemical and other substances, apparatus and appliances for use in connection therewith. The first subscribers (each with one share) are:—R. Warner, 10, Walbrook, E.C., accountant; A. Castle, 37, Walbrook, E.C., gentleman; H. R. Westau, 10, Walbrook, E.C., accountant; H. W. Quittenden, 10, Sudborne Road, Brixton, S.W., gentleman; H. Munford, 2, Heath Villas, Rosslyn Park, Earlsfield, S.W., gentleman; J. A. Bush, 184, Seymour Street, N.W., gentleman; and P. E. H. Sewell, 36, Manor Road, Brockley, gentleman. The number of directors is not to be less than three nor more than five; the subscribers are to appoint the first; qualification, £50.

SUPPLY STATION ACCOUNTS.

Harrogate Corporation Electricity Accounts.

The supply of electrical energy was commenced in Harrogate under Mr. G. Wilkinson's supervision in April, 1897. The district has a population of about 20,000, and the works are, therefore, comparatively small, but are being rapidly extended. The growth of the business is shown by the following figures:—

	Capital.	Number of units sold.	Maximum load.	Gross profit.
1897	£27,298	62,622	132 kw.	— £704
1898	£38,730	201,363	198 „	+ 1,869
1899	£50,270	365,404	348 „	+ 3,085

In 1897 to 1898 the capital expenditure increased by £11,432, and this was almost exactly the figure again for 1898 to 1899. The load, and more particularly the units, rose more rapidly last year than in the previous one, so that the business seems to have plenty of scope.

General Statement.

	1898.	1899.	Increase.
Total capital expenditure ...	£38,730	**£50,270**	£11,540
Number of units sold	201,363	**365,404**	164,041
Maximum load in kw.	198	**348**	150
Gross revenue	£4,672	**£6,534**	£1,862
Gross expenditure	£2,803	**£3,449**	£646
Gross profit	£1,869	**£3,085**	£1,216
Average price per unit sold ...	5·46d.	**4·12d.**	— 1·34d.

The revenue from all sources has increased by the substantial sum of £1,862, which is accompanied by a reduction in the receipts from sale of energy of 1½d. per unit. At 5½d. the price was rather high. It now stands at just over 4d., and the reduced tariff should encourage custom. No doubt it is to this that may be attributed the improved financial position. The receipts from various sources other than energy and meter rents show an appreciable increase, resulting in the fall per unit on the gross figure coming out at about 1½d.

Revenue Statement.

	1898. Gross.	1898. Per unit.	1899. Gross.	1899. Per unit.	Increase
Sale of energy, &c.	£4,582	5·46d.	**£6,272**	4·12d.	—1·34d.
Meter rents, &c...	84	·10d.	**129**	·08d.	—·02d.
Supply of lamps, &c.	...	...	**133**	·09d.	+·08d.
Sundry fees	6	·01d.	...	...	
Gross revenue ...	£4,672	5·57d.	**£6,534**	4·29d.	—1·28d.

The costs deserve particular notice at a time when increases are unfortunately only too common. Coal is now well below 1d., and the reduction amounts to no less that ½d. in spite of higher market rates. Wages are very moderate at just over ½d. The engineering economies have brought the works cost below 2d., and the comparatively small increments in the other items have allowed the total costs to be reduced by over 1d. to the figure of about 2¼d. Mr. Wilkinson must be congratulated upon the steady reductions which, coupled with the increased output, have turned a deficit into a profit.

Cost of Production.

	1898. Gross.	1898. Per unit.	1899. Gross.	1899. Per unit.	Increase.
Coal	£1,027	1·23d.	£1,339	**·88d.**	— ·35d.
Oil, waste, water and engine room stores.	159	·19d.	228	**·15d.**	— ·04d.
Salaries and wages incurred in generation and distribution.	692	·82d.	803	**·53d.**	— ·29d.
Repairs and maintenance of buildings, engines, boilers, dynamos, &c.	384	·46d.	503	**·33d.**	— ·13d.
Works costs ...	£2,262	2·70d.	£2,873	**1·89d.**	— ·81d.
Rent, rates and taxes ..	128	·15d.	106	**·07d.**	— ·08d.
Management expenses, salaries of managing engineer, secretary, clerks, &c.	301	·36d.	339	**·22d.**	— ·14d.
General establishment charges, stationery and printing, law charges and insurance	112	·13d.	131	**·09d.**	— ·04d.
Other expenses	...	...	...	...	...
Total costs ...	£2,803	3·34d.	£3,449	**2·27d.**	—1·07d.

The profit statement contains a curious item, *i.e.*, a reduction in the interest amount. Taking the financial charges for 1899, it appears that they are less by £289 than in 1898. As the gross profit increased by £1,216, the loss of £728 in 1898 was not only met, but the amount of £777 was left over as surplus, indicating that the corner has been turned, and the business is now easily paying its way.

Profit Statement.

	1898.	1899.
Interest on loans	£1,445	£1,019
Sinking fund for repayments	1,152	1,289
Net profit carried forward	—728	777
Gross profit	£1,869	£3,085

CITY NOTES.

Direct West India Cable Company, Limited.

The report of the directors presented to the meeting held on September 27th, reads as follows:—

The directors beg to submit to the shareholders duly audited statements of account to June 30th, 1900. The net result is a profit of £5,455 18s. 3d., which is satisfactory, considering the circumstances under which the company has to work, but it compares unfavourably with a profit of £19,186 1s. 1d. made in the previous year when revenue was greatly aided by the Spanish-American war and other unusual occurrences. An interim dividend of 2½ per cent. has already been paid, and it is now proposed to make a further distribution of 3½ per cent., which will leave £3,655 18s. 3d. to be carried forward, thereby increasing the amount to the credit of revenue account to £25,146 15s. 1d. The company's cables continue to work with complete efficiency. Under the deed the redemption of the company's debentures commenced in June last and £9,000 of debentures have been acquired and cancelled, which amount has been written off capital expenditure. Mr. Geo. G. Ward and Mr. Fred. Ward retire on this occasion, and being eligible, offer themselves for re-election. Messrs. Gribbon, Holroyd and West, the auditors, retire, and offer themselves for re-election.

Hálifax and Bermudas Cable Company, Limited.

The report presented at the eleventh annual meeting, held on September 27th, reads as follows:—

The directors beg to submit to the shareholders duly audited statements of account for the year ending June 30th, 1900. The net result of the year's working is a profit of £3,795 7s. 9d., as compared with £10,141 19s. 10d. for the previous year. This important reduction is mainly due to normal times as compared with a period which was benefited largely by traffic arising from the Spanish-American war. An interim dividend of 2½ per cent. has already been paid, and it is now proposed to make a further equal payment, which will together absorb £2,500, and leave £1,295 7s. 9d. to be carried forward. This will increase the amount to the credit of revenue account to £18,093 8s. 3d. The company's cable continues to work with complete efficiency. Offers for the sale of debentures to the trustees were invited in December and June last, and £5,197 2s. 5d. was paid for £5,200 of debentures, which amount has been written off capital expenditure. Mr. Geo. G. Ward and Mr. Fred. Ward retire on this occasion, and being eligible, offer themselves for re-election. The auditors, Messrs. Gribbon, Holroyd and West, retire, and offer themselves for re-election.

The report was adopted unanimously.

Newcastle-upon-Tyne Electric Supply Company.

The report of the directors of the Newcastle Electric Supply Company, Limited, on the extended Parliamentary powers secured by the company, states that both the Bill to secure powers to the company outside the area defined by their original provisional order, and the provisional order for the supply of electricity to Gosforth, have now received the Royal Assent and passed into law. The

death."

Clapham Park.

competition with which the company was threatened by the introduction, during the past Parliamentary session, of the Tyneside Electric Power Company's Bill, has been removed by the promoters having failed to secure their Bill. The acquisition of the powers and rights, secured by special Acts of Parliament and provisional orders, entails upon the company the obligation of taking immediate steps for the generating and supplying of electricity in the whole of the area for which they have powers. This will necessitate considerably extended capital powers, and it is the intention of the directors, as soon as their plans are matured, to approach the shareholders and, if necessary, the public, with the object of securing the additional capital required. In the meantime the organisation of the company requires to be at once extended and strengthened, and the object which the directors have in calling the shareholders together at the present time is to explain the new and greatly improved position of the company's prospects, and to vary the articles of association so as to allow of an increase in the numbers of directors by the addition of such gentlemen as are willing and able to assist the present directorate in the maturing and carrying out of the extended plans and operations, which will result in the erection of a large power station capable of supplying energy over the whole of the company's area.

An extraordinary general meeting of shareholders was called for Thursday, October 4th, and the directors suggested the shareholders' approval of the election as directors of Sir Lindsay Wood, Bart., and Mr. John H. B. Noble.

Stock Exchange Notices.—Application has been made to the Committee to appoint a special settling day in, and to grant a quotation to — Telegraph Manufacturing Company, Limited—Further issue of 5,000 shares of £5 each, fully paid; and they have appointed a special settling day as under:—Thursday, October 11th, Eastern Extension, Australasia and China Telegraph Company, Limited—Further issue of 50,000 shares of £10 each (issued at £3 per share premium), £5 paid (of which £3 is capital and £3 is premium), Nos. 250,001 to 300,000, and has ordered same to be officially quoted; also British Columbia Electric Railway Company, Limited—Further issue of 1,600 5 per cent. non-cumulative preference shares of £10 each, fully paid, Nos. 37,001 to 38,600.

Anglo-American Telegraph Company, Limited.—The directors have resolved, after placing £6,000 to the credit of the renewal fund, to declare an interim dividend for the quarter ending September 30th, 1900, of 15s. per cent. on the ordinary stock and £1 10s. per cent. on the preferred stock, less income-tax, payable on November 1st.

Eastern Telegraph Company.—The directors announce payment on 15th prox. of a dividend at the rate of 3½ per cent. per annum on the preference stock of the company for the quarter ending 30th inst., and the usual interim dividend of 1½ per cent. on the ordinary stock, in respect of profits for the quarter ended June 30th.

Recording Telegraphs Company.—An extraordinary general meeting was held at Winchester House on Monday, Mr. J. A. Sillars presiding, when a resolution for winding up voluntarily was passed.

British Electric Traction Company.—Warrants for the debenture interest have been posted.

TRAFFIC RECEIPTS.

The Blackpool and Fleetwood Tramroad Company.—The receipts for the week ending September 29th, 1900, were £767 18s. 8d.; receipts for corresponding period, 1899, £768 2s. 4d.; aggregate for half-year to date, £17,662 19s. 2d.; aggregate corresponding period of last half-year, £17,536 0s. 6d.

The Bristol Tramways and Carriage Company.—The receipts for the week ending September 28th, 1900, were £3,402 19s. 8d.; corresponding period, 1899, £3,059 17s. 3d.; increase, £343 2s. 5d.

The Central London Railway.—The receipts for the week ending September 29th, 1900, were £5,508; previous week, £4,891; increase, £317. Total receipts to September 29th, 1900 (9 weeks), £42,407. Miles open, 6.

The City and South London Railway Company.—The receipts for the week ending September 30th, 1900, £1,574; October 1st, 1899, £963; increase, £611. Total receipts for half-year, 1900, to date, £19,621; corresponding period, 1899, £12,185; increase, £7,436. Miles open, 1900, 4½; 1899, 3½.

The Cork Electric Tramways and Lighting Company.—The receipts for the week ending Thursday, September 27th, 1900, were £443 15s. 9d.; corresponding week last year, £396 3s. 9d.; increase, £47 12s. 0d. Total to September 27th, 1900, £16,167 2s. 7d.; corresponding period last year, £14,849 3s. 11d.; increase, £1,317 18s. 8d.

The Dover Corporation Tramways.—The receipts for the week ending September 29th, 1900, were £255 9s. 10d.; September 30th, 1899, £210 13s. 0d.; increase, £44 16s. 10d. Total receipts to date, 1900, £8,233 12s. 2½d.; corresponding period, 1899, £7,872 14s. 0d.; increase, £360 18s. 2½d. Miles of track open, 1900, 3; 1899, 3. Car miles run, 1900, 5,164; 1899, 4,864. Number of cars, 1900, 11; 1899, 11.

The Dublin United Tramways Company.—The receipts for the week ending Friday, September 28th, 1900, were as follows:—D. U. T. Co., horse cars, £27 3s. 1d.; ditto, electric cars, £3,651 10s. 11d.; D. S. D. Co., electric cars, £854 15s. 3d.; total, £4,533 9s. 3d; corresponding week last year—D. U. T. Co., horse cars, £1,062 18s. 2d.; ditto, electric cars, £1,993 19s. 11d.; D. S. D. Co., electric cars, £785 4s. 4d.; total, £3,782 2s. 6d.; increase, £751 6s. 10d.; aggregate to date, £65,183 17s. 10d.; aggregate to date last year, £58,667 2s. 6d.; increase to date, £6,466 15s. 4d. The mileage worked is 43 miles electrically, 1 mile by horses, as against 24 miles electrically, 20 miles by horses, for the corresponding period last year.

The Liverpool Overhead Railway Company.—The receipts for the week ending September 30th, 1900, were £1,685; corresponding week last year, £1,481; increase, £204. Total traffics from July 1st, 1900, £22,680; ditto corresponding period, 1899, £21,617; increase, £1,069. Miles open, 6·57 chains.

STOCKS AND SHARES.

Wednesday Evening.

The General Election, the situation in the Far East, and the strength of the Money Market are now arrayed in powerful combination to prevent the accession of business that the Stock Exchange had lately prophesied would come at the last quarter of the year. Trade is so quiet in Capel Court that many members have prolonged their holidays, and the cry is continually ascending that office expenses are not being paid. Under these circumstances the Electrical Markets should be duly grateful for the support that is accorded them, despite the absence of business. In the supply department three of the principal investment shares are 10s. to the good. Telegraph stocks are without any significant alteration, and the Electric Railway descriptions are the merest shade better.

We are able to announce that next week will see the public *début* of an important addition to the list of manufacturing companies. It will be issued under the style of the General Electric Company, with a share capital of £800,000 divided into equal proportions of Ordinary and Preference. There will also be Debentures to the tune of £200,000. The vendors, it will be found when the prospectus appears, are taking all the Ordinary share capital in part payment of the purchase money, and also stipulate for a certain amount of the Preference shares and Debentures. The General Electric Company, as our readers are aware, is already existent, but the small private company now known by that name will give place to the large public enterprise, and its issue will be of particular interest in so quiet a season for capital appeals as the present is.

Negotiations are on foot for the acquisition of the Bournemouth and Poole Electric Supply Company by the local authority. In anticipation of the undertaking fetching a good price, the Ordinary and Preference shares have been advanced this week to 12½ and 10½ respectively. This is very much in the nature of a step in the dark, as nothing is known yet as to the price which may—or may not—be offered. The company's capital is £150,000, divided into moieties of Preference and Ordinary shares of £10 each, and there is a Debenture issue, of recent date, amounting to £70,000. As regards electric lighting shares other than those of companies that operate in the metropolis, Oxford Ordinary are £6, Calcutta 6½, Blackheath and Greenwich Ordinary 10s., and Royal Electric of Montreal ($100 shares) 175.

The trio of rises alluded to as having occurred in the supply section have been induced by a small amount of buying helped by bear covering on behalf of some of the dealers in the market, who found themselves short of shares in consequence, partially, of the gradual merging of new into existing issues that is taking place. Metropolitan new are now dealt in for the special settlement, and are quoted at £3 premium, which is 15s. up on the week. The old shares have also recovered the 10s. that they lost, Westminsters doing exactly the same. St. James's and Pall Mall are now 15½, which is a sovereign below the highest price touched this year, and 1⅜ above the lowest. In 1899 the extreme fluctuations were between 18 and 15, so that there would seem to be some room for a further rise. There are now no new St. James's, but the latest Westminsters are quoted at 11½, being dealt in for the ordinary account.

Central London "splits" are being wanted, both classes putting on 5s. to their price. The Preferred are entitled to 4 per cent. out of the dividend declared on the Ordinary, any balance going to the Deferred. Market calculations are at present pointing to 4 per cent. being paid on the Ordinary for the first year's working, which justifies the two descriptions of divided shares standing at the same quotation. As we pointed out a fortnight ago, it is impossible to tell what profit the Central London is making, because no data concerning expenses are yet available, and dividend guesses must of necessity be exceedingly vague.

In our last week's issue we drew attention to the proposed electrifying of the Mersey Railway, and it is evident that some drastic measures must be resorted to before the company can be placed in a paying position. The Ordinary share capital is nearly 1½ millions sterling, upon which not a penny has been paid by way of dividend since the shares were issued in 1881. The fully paid £20 shares are quoted at 15s. This is a worse record than that of the Metropolitan District, whose stock has fallen sharply this week, being now no better than 24¾. Metropolitan Consolidated is also flat at 93, and the two companies are said to be in a bad way, the District more particularly.

Beyond a weakening of Anglo-American "A" and "B" stocks, the telegraph market shows very little change, prices being well maintained, but business not displaying any evidence of return. National Telephone shares have been flat, but are above the worst recorded price. A good many shares have come on the market from the provinces, and the result of the company's latest lawsuit does not tend to reassure shareholders.

Gross revenue ...	£4,672	5·57d.	£6,534	4·29d.	−1·28d.

and the provisional order for the supply of electricity to Gosforth, have now received the Royal Assent and passed into law. The

SHARE LIST OF ELECTRICAL COMPANIES.—TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. †	Dividends for the last three years. 1897.	1898.	1899.	Closing Quotation September 26th.	Closing Quotation October 3rd.	Business done during week ended October 3rd, 1900. Highest.	Lowest.
110,900	African Direct Telegraph, 4 % Debs.	100	...	...	...	99 —103	99 —103	...	...
125,000	Amazon Telegraph 5 % Debs., Nos. 1 to 1,250 Red. ...	100	...	...	...	85 — 90	85 — 90	...	...
875,520	Anglo-American Telegraph	Stock	3 %	£3 9s.	73/6	59 — 62	59 — 62	61½	61
3,062,240	Do. do. 6 % Pref.	Stock	6 %	6 %	6 %	110 111	109½—110½	110⅝	110
3,062,240	Do. do. Deferred	Stock	...	18s. %	£1 7s.	11½— 12	11 — 11½	11⅝	11½
44,000	Chili Telephone, Nos. 1 to 44,000	5	4 %	3 %	4 %	2½— 3½	2½— 3½	...	...
10,000,000$	Commercial Cable	$100	8 %	8 %	8 %	165 —175	165 —175 xd	...	...
1,563,078£	Do. do. Sterling 500 year 4 % Deb. Stock Red.	Stock	...	...	...	101 —103	100 —102 xd	102½	...
16,000	Cuba Telegraph	10	7 %	8 %	7 %	6½— 7½	6½— 7½	...	...
6,000	Do. 10 % Pref.	10	10 %	10 %	...	15 — 16	15 — 16	...	...
12,931	Direct Spanish Telegraph	5	4 %	4 %	4 %	4 — 5	4 — 5 xd	...	...
6,000	Do. do. 10 % Cum. Pref.	5	10 %	...	...	9 — 10	9 — 10 xd	...	...
30,000	Do. do. 4½ % Debs.	50	...	...	...	100 —104 %	100 —104%	...	...
60,710£	Direct United States Cable	20	3½%	3½%	3 %	10⅜— 11½	10⅜— 11½	11⅝	...
111,000	Direct West India Cable, 4½ % Reg. Deb.	100	...	...	...	99 —102	99 —102	...	...
4,000,000	Eastern Telegraph, Ord. Stock	Stock	7 %	7 %	7 %	149 —154	149 —154	152½	151
1,795,000	Do. 3½ % Pref. Stock	100	...	...	...	99 —102	99 —102	...	...
1,432,268£	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	...	...	114 —119	114 —119	115⅝	114
250,000	Eastern Extension, Australasia, and China Telegraph ...	10	7 %	7 %	7 %	15 — 15¼	15 — 15½	15⅝	15
6,700£	Do. 5 % (Aus. Gov. Sub.) Deb., 1900, red. ann. drgs., reg. 1—1,049, 3,976—4,326	100	5 %	...	...	... — ...	... — ...	...	...
26,600£	Do. do. Bearer, 1,050—3,975, 4,327—6,400	100	5 %	...	...	... — ...	... — ...	...	...
320,000£	Do. 4 % Deb. Stock	Stock	4 %	...	...	113 —118	113 —118	...	...
300,000£	Eastern and South African Telegraph, 4 % Mort. Deb. Nos. 1 to 3,000, red. 1909	100	...	...	...	99 —102	99 —102	...	...
200,000£	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1—8,000	25	...	...	...	100 —103%	100 —103%	...	...
180,227	Globe Telegraph and Trust	10	4½%	5½%	5½%	10⅜—11½	10⅜— 11½	11 1/16	10⅜
180,042	Do. do. 6 % Pref.	10	6 %	6 %	...	14⅜— 15½	15 — 15½	15½	14⅜
150,000	Great Northern Telegraph, of Copenhagen	10	10 %	12½%	...	32 — 34	31 — 33	...	...
84,300	Halifax and Bermuda Cable, 4½ % 1st Mort. Debs., within Nos. 1 to 1,200, Red.	100	...	...	...	98 —101	98 —101	...	...
17,000	Indo-European Telegraph	25	10 %	10 %	10 %	49 — 53	49 — 53	...	...
100,000£	London Platino-Brazilian Telegraph, 6 % Debs.	100	6 %	...	...	103 —106	103 —106	...	...
72,680	Montevideo Telephone, Limited, Ord., Nos. 1 to 72,680 ...	1	...	...	...	¼— ⅛	¼— ⅛	...	...
86,492	Do. do. do. 5 % Pref., Nos. 1 to 86,492	1	4 %	4 %	2½%	¾— 1	¾— 1	...	...
490,000	National Telephone, 1 to 490,000	5	6 %	6 %	5 %	4⅛— 4⅜	4⅛— 4⅜	4⅜	...
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	13 — 15	13 — 15	14	13 1/16
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	13 — 15	13 — 15	...	...
250,000	Do. 5 % Non-cum. 3rd Pref., 1 to 250,000	5	5 %	5 %	6 %	5 — 5¼	5¼— 5⅜	...	...
2,000,000£	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	98 —101	97 —100	99⅜	...
171,504	Oriental Telephone and Elec., Nos. 1 to 171,504, fully paid	1	5 %	5 %	5 %	⅞— 1⅛	⅞— 1⅛	...	...
100,000£	Pacific and European Tel., 4 % Guar. Debs., 1 to 1,000 ...	100	4 %	...	...	100 —103	100 —103	...	...
11,839	Reuter's	8	5 %	5 %	5 %	7 — 8	7 — 8	...	...
3,381	Submarine Cables Trust	Cert.	...	...	...	126 —131	126 —131	...	...
58,000	United River Plate Telephone	5	5 %	6 %	7 %	4⅜— 5½	4⅜— 5½	4 1/16	...
16,639	Do. do. 5 % Cum. pref. Nos. 1—16,639	5	...	...	...	4⅜— 5½	4⅜— 5½	5 1/16	...
179,947	Do. do. 5 % Debs.	Stock	...	...	...	104 —107	104 —107	...	...
200,000£	West African Telegraph, 5 % Debs....	100	...	...	...	98 —101	98 —101	...	...
30,008	West Coast of America, Nos. 1—30,000 and 53,011—53,008	2½	...	...	...	½— 1	½— 1	...	...
150,000	Do. do. 4 % Debs., 1—1,500 gua. by Brаz. Sub. Tel.	100	...	...	...	100 —103	100 —103	...	...
389,731	Western and Brazilian Telegraph 4 % Deb. Stock Red. ...	Stock	...	...	...	... — ...	... — ...	...	...
207,930	Western Telegraph, Ltd., Nos. 1—207,930	10	7 %	7 %	...	14⅜— 15½	14⅜— 15½	15⅛	14⅞
75,000	Do. do. 5 % Debs. 2nd series, 1906 ...	100	...	...	...	103 —106	103 —106	...	...
88,321	West India and Panama Telegraph	10	⅜%	2 %	⅛%	⅜— 1	⅜— 1	...	...
34,563	Do. do. do. 6 % Cum. 1st Pref. ...	10	6 %	...	...	6½— 7½	6½— 7½	6⅞	...
4,669	Do. do. do. 6 % Cum. 2nd Pref. ...	10	6 %	...	...	6 — 7	6 — 7	...	...
80,000£	Do. do. do. 5 % Debs., Nos. 1 to 1,800	100	5 %	...	...	105 —108	105 —108	...	...

ELECTRICITY SUPPLY COMPANIES.

19,661	Brompton & Kensington Elec. Lt. Sup., Ord., 101 to 19,761	5	4 %	6 %	6 %	7 — 8	7 — 8	...	...
12,000	Do. do. 7 % Cum. Pref....	5	7 %	...	...	8½— 9½	8½— 9½	...	...
50,000	Charing Cross and Strand Electricity Supply	5	7 %	8 %	9 %	9 — 10	9 — 10	9⅜	...
20,000	Do. do. do. do. 4½% Cum. Pref.	5	...	...	...	5½— 5⅝	5½— 5⅝	...	...
34,000	*Chelsea Electricity Supply, Ord.	5	6 %	6 %	6 %	6½— 7½	6½— 7½	...	...
150,000	Do. do. do. % Deb. Stock Red. ...	Stock	4½%	...	...	110 —113	110 —113	...	...
60,000	City of London Electric Lighting, Ord. 40,001—100,000...	10	10 %	6 %	4 %	8½— 9½	8½— 9½	...	...
40,000	Do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	...	12½— 13½	12½—13½	...	...
400,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	...	...	124 —129	124 —129	...	...
40,000	County of Lond. & Brush Prov. Elec. Ltg., Ord. 1—40,000	10	*nil*	*nil*	4 %	8½— 9½	8½— 9½	...	...
20,000	Do. do. do. 6 % Pref., 40,001—60,000	10	6 %	6 %	...	11 — 12	11 — 12	11⅞	...
200,000	Do. 4½ % Deb. Stock, Prov. Certs (all paid) Rd. ...	...	...	...	...	107 —110	107 —110	...	...
26,100	Edmundson's Elec. Corp., Ord. Shares	5	5 %	7 %	...	4½— 5	4½— 5	...	...
75,000	Do. do. 4½ % 1st Mort. Deb. Stock. ...	100	...	...	...	100 —103	100 —103	...	...
110,000	London Electric Supply Corporation, Limited, Ord. ...	3	...	...	...	1⅜— 2¼	1⅜— 2¼	...	...
49,840	Do. do. do. do. 6 % Pref.	5	...	6 %	...	4½— 5½	4½— 5½	...	...
250,000	Do. do. do. 4% 1st Mt. Db. Stock Rd.	Stock	...	...	...	100 —102	100 —102	101½	101
85,000	Metropolitan Electric Supply, 101 to 62,500	10	6 %	5 %	5 %	12½— 13½	13 — 14	13⅜	13 1/16
220,000£	Do. 4½% First Mortgage Debenture Stock	...	4½%	...	...	111 —114	111 —114	...	...
220,000	Do. 3½ % Mort. Deb. Stock Red.	Stock	...	...	...	97 — 100	97 —100	98⅜	98½
6,452	Notting Hill Electric Lighting	10	6 %	6 %	7 %	14½— 15½	14½— 15½	...	...
40,000	St. James's and Pall Mall Electric Light, Ord.	5	14½%	14½%	14½%	14½— 15½	15 — 16	15½	15
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	8 — 9	8 — 9	8 1/16	..
12,000	Smithfield Market Elect. Supply, Ord.	5	...	...	...	2 — 2½	2 — 2½	...	...
50,000	Do. do. 4 % Deb.	100	...	...	...	85 — 95	85 — 95	...	...
65,000	South London Electricity Supply, Ord.	5	...	...	...	3 — 4	3 — 4	3¼	...
79,900	Westminster Electric Supply, Ord., 101 to 80,000... ...	5	12 %	12 %	13 %	11½— 12½	12 — 13	13¼	12½

* Subject to Founders Shares.
† Unless otherwise stated all shares are fully paid.
‡ Dividends paid in deferred share warrants, profits being used as capital.
§ Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.
Quotations on Liverpool Stock Exchange.

increase, £204. Total traffics from July 1st, 1900, £23,680; ditto corresponding period, 1899, £21,617; increase, £1,063. Miles open, 6·57 chains.

the provinces, and the result of the company's latest lawsuit does not tend to reassure shareholders.

SHARE LIST OF ELECTRICAL COMPANIES.—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL COMPANIES.

Present Issue.	NAME.	Stock or Share.	Dividends for the last three years. 1897.	1898.	1899.	Closing Quotation Sept. 26th.	Closing Quotation Oct. 3rd.	Business done week ended Oct. 3rd, 1900 Highest	Lowest.
20,000	British Aluminium 7 % Cum. Pref.	‡ 10	...	...	...	...	9 — 10	...	...
300,000	Do. do. 5 % 1st Mort. Deb. Stock Red. ...	Stock	...	...	...	...	93 — 97	...	...
30,000	British Electric Traction	10	...	6 %	...	14 — 15	14 — 15	14¾	...
50,000	Do. do. 6 % Cum. Pref.	10	...	...	...	12 — 13	12 — 13	12⅝	12¼
200,000	Do. do. 5 % Perpetual Debenture Stock ...	Stock	...	...	...	123 —126	120 —123xd	122	121
85,000*l*	†British Electric Works Co., Ord. £1 shares, 50,001—135,000	...	...	...	...	⅜— ½	⅜— ½	...	...
50,000	† Do do. 6 % Cum.Pref., 1—50,000 ...	...	...	...	...	⅜— ½	⅜— ½	...	...
500	† Do. do. 4½ % 1st Mort. Deb.	100	...	...	...	97 — 99	97 — 99	...	...
40,000	British Insulated Wire Ord., Nos. 1 to 40,000	5	15 %	15 %	20 %	11 — 12	11 — 12	...	...
27,500	Do. do. 6 % Cum. Pref. Nos. 1 to 27,000 ...	5	...	...	...	5⅜— 6¼	5⅜— 6¼	...	...
105,731	Brush Elecl. Engineering, Ord., 1 to 90,000	2	3 %	5 %	6 %	1⅝— 2	1⅝— 2	...	...
105,731	Do. do. Non-cum. 6 % Pref., 1 to 90,000 ...	2	6 %	6 %	6 %	2⅛— 2⅜	2⅛— 2⅜	2 3/16	...
125,000*l*	Do. do. 4½ % Perp. Deb. Stock	Stock	...	...	...	106 —111	106 —111	...	...
125,000	Do. do. 4½ % Perp. 2nd Deb. Stock ...	Stock	...	...	...	101 —103	102 —104	103	102⅜
20,000	Callender's Cable Construction shares, Nos. 1—20,000 ...	5	12½%	15 %	15 %	12⅓— 13⅓	12⅓— 13⅓	13⅛	...
20,000	Do. do. 5 % Cum. Pref.	5	...	...	...	5 — 5½	5 — 5½	5 1/16	...
90,000	Do. do. 4½ % 1st Mort. Deb. Stock Red ...	S ock	...	...	...	110 —114	110 —114	...	...
213,533	Central London Railway, Ord. Shares	10	...	...	...	10 — 10½	10 — 10½	10½	10 3/16
61,033	Do. do. Pref. half-shares	5	...	...	...	4⅜— 5½	5 — 5½	5 1/16	5⅛
71,447	Do. do. Def. do.	5	...	...	...	4⅜— 5½	5 — 5½	5 1/16	5⅛
855,000	City and South London Railway	Stock	1⅞%	2⅛%	1⅞%	58 — 61	58 — 61	...	...
37,500	Do. do. Ord. shares Nos. 22,501 to 60,000 ...	10	...	...	...	5 — 6	5 — 6	6	...
32,098	Crompton & Co., Nos. 1 to 32,098	3	...	6 %	7½%	3¾— 4¼	3¾— 4¼	...	...
100,000	Do. 5 % 1st Mort. Reg. Debs., 1 to 900 of £100, and 901 to 11,000 of £50 red	...	...	...	...	99 —102	99 —102	...	...
99,261	Edison & Swan Utd. El. Lgt., "A" shares, £3 pd. 1 to 99,261	5	6 %	6 %	6 %	1¾— 2¼	1¾— 2¼	...	...
17,139	Do. do. do. "A" Shares, 01—017,139 ...	5	6 %	6 %	6 %	3½— 4¼	3½— 4¼	...	...
344,023	Do. do. do. 4 % Deb. Stock Red ...	100	...	...	...	90 — 92	90 — 92	90⅜	...
112,100	Electric Construction, 1 to 112,100	2	6 %	6 %	6 %	2 — 2¼	2 — 2¼	2⅛	2 1/16
25,000	Do. do. 7 % Cum. Pref., 1 to 25,000... ...	2	7 %	7 %	...	2¾— 3¼	2¾— 3¼	...	...
140,300	Do. do. 4 % Perp. 1st Mort. Deb. Stock ...	Stock	...	...	...	102 —105	102 —105	101	...
9,600*l*	Greenwood & Batley, 7 % Cum. Pref., 1 to 9,600	10	7 %	7 %	7 %	10 — 11	10 — 11	...	...
30,000	Henley's (W. T.) Telegraph Works, Ord.	5	12 %	14 %	15 %	12½— 13½	12½— 13½	...	...
30,000	Do. do. do. 4½ % Pref.	5	7 %	7 %	...	5 — 5½	5 — 5½	5⅜	...
50,000	Do. do. do. 4½ Mort. Deb. Stock...	Stock	4½%	...	...	108 —112	108 —112	...	...
50,000	India-Rubber, Gutta-Percha and Telegraph Works ...	10	10 %	10 %	...	20½— 21½	20½— 21½	...	...
300,000	Do. do. do. 4 % 1st Mort. Deb	100	...	...	...	99 —102	99 —102 xd	100	...
37,500	†Liverpool Overhead Railway, Ord.	10	3½%	3½%	3⅜%	8⅜— 8⅝	8⅜— 8⅝	...	...
10,000	† Do. do. Pref., £10 paid	10	5 %	5 %	5	12⅜— 13½	12⅜— 13½	...	...
37,350	Telegraph Construction and Maintenance	12	15 %	15 %	15 %	34 — 38	34 — 38	36	34½
150,000	Do. 4 % Deb. Bds. Nos. 1 to 1,500 Red. 1909 ...	100	...	...	... %	101 —104	101 — 104	...	...
20,000	Telegraph Manufacturing, Ord. Nos. 1 to 20,000	5	...	8 %	12 %	10½— 11½	10½— 11½	10 13/16	...
20,000	Do. do. 5 % Cm. Prf. Nos. 1 to 20,000...	5	...	...	...	5¼— 5¾	5 — 5½xd	...	...
540,000*l*	Waterloo and City Railway, Ord. Stock	100	...	3 %	3 %	92 — 95	92 — 95	...	...

† Quotations on Liverpool Stock Exchange.

‡ Unless otherwise stated all shares are fully paid.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Brompton and Kensington, 4½ % Debentures of £100, 103—106.
National Electric Free Wiring, 12/6 paid, 7/-—10/-.
Oldham, Ashton, and Hyde Electric (£10 pd.), Ord., 16½—17½.
Do. do. Pref. (£10 pd.), 10¾.
* From Birmingham Share List.

Kensington and Knightsbridge Electric Lighting, Ordinary Shares £5 (fully paid) 12—13; 1st Preference Cumulative 6 % £5 (fully paid), 6½—7½. Debentures, 102—105. Dividend, 1899, on Ordinary Shares 11 %.
*T. Parker, £10 (fully paid), 17¾.

Bank rate of discount 4 per cent. (July 19th, 1900).

MARKET QUOTATIONS, Wednesday, October 3rd.

CHEMICALS, &c.		This week.	Last week.	Inc. or Dec.
a Acid, Hydrochloric	per cwt.	5/-	5/-	..
a ,, Nitric	per cwt.	22/-	22/-	..
a ,, Oxalic	per cwt.	32/-	32/-	..
a ,, Sulphuric	per cwt.	5/6	5/6	..
a Ammoniac, Sal	per cwt.	39/-	39/-	..
a Ammonia, Muriate (crystal) ..	per ton	£33	£33	..
a ,, ,, ..	per ton	£30	£30	..
a Bleaching powder	per ton	£7	£7	..
a Bisulphide of Carbon	per ton	£15	£15	..
a Borax	per ton	£17	£17	..
a Bensole (90 %)	per gal.	7/-	7/-	..
a ,, (50/90%)..	per gal.	5/6	5/6	..
a Copper Sulphate	per ton	£25	£25	..
a Lead, Nitrate	per ton	£25	£25	..
a ,, White Sugar	per ton	£31	£31	..
a ,, Peroxide	per ton	£27 10	£27 10	..
a Methylated Spirit	per gal.	2/6	2/6	..
a Naphtha, Solvent (90% at 160° C).	per gal.	5/6	5/6	..
a Potash, Bichromate, in casks..	per lb.	3¼d.	3¼d.	..
a ,, Caustic (75/80%) ..	per ton	£24	£24	..
a ,, Bisulphate	per ton	£35	£35	..
a Shellac	per cwt.	66/-	65/-	1s. inc.
a Sulphate of Magnesia	per ton	£4 10	£4 10	..
a Sulphur, Sublimed Flowers ..	per ton	£6	£6	..
a ,, Recovered	per ton	£5 10	£5 10	..
a ,, Lump	per ton	£5	£5	..
a Soda, Caustic (white 70 %) ..	per ton	£10 15	£10 15	..
a ,, Crystals	per ton	£3	£3	..
a ,, Bichromate, casks ..	per lb.	2¾d.	2¾d.	..
METALS, &c.				
b Aluminium Wire, in ton lots..	per ton	£224	£224	..
b ,, Sheet, in ton lots	per ton	£191	£191	..
p Babbitt's metal ingots.. ..	per ton	£80 to £150	£80 to £145	..
c Brass (rolled metal 2' to 12') basis	per lb.	7¾d.	7¾d.	..
c ,, Tube (brazed)	per lb.	10d.	10d.	..
c ,, ,, (solid drawn) ..	per lb.	8¼d.	8¼d.	..
c ,, Wire, basis	per lb.	8¼d.	8¼d.	..
c Copper Tubes (brazed) ..	per lb.	11½d.	11½d.	..
c ,, ,, (solid drawn) ..	per lb.	11d.	11d.	..
g Copper Bars (best selected) ..	per ton	£86	£86	..

METALS, &c. *(continued.)*		This week.	Last week.	Inc. or Dec.
g Copper Sheet	per ton	£86	£86	..
g ,, Rod	per ton	£86	£86	..
e ,, (Electrolytic) Bars ..	per ton	£93 10	£93 10	..
e ,, ,, Sheets ..	per ton	£92	£92	..
e ,, ,, Rod	per ton	£85 10	£85 10	..
e ,, ,, H.C. Wire	per lb.	9¾d.	9¾d.	..
f Ebonite Rod	per lb.	8/-	8/-	..
f ,, Sheet	per lb.	5/-	5/-	..
n German Silver Wire	per lb.	1/6	1/6	..
h Gutta-percha fine	per lb.	8/6	8/6	..
h India-rubber, Para fine	per lb.	4/3	4/3 to 4/4	..
i Iron, Charcoal Sheets	per ton	£18	£18	..
i ,, Pig (Cleveland warrants) ..	per ton	67/-	71/9	4s. 9d. dec.
i ,, Forgings, according to size	per ton	From £11	From £11	..
i ,, Scrap, heavy	per ton	70/- to 72/6	70/- to 72/6	..
i ,, Wire, galvanised No. 8 ..	per ton	£12 5	£12 15	10s. dec.
g Lead, English Ingot	per ton	£18 5 to £18 7 6	£18 to £18 2 6	5s. inc.
g ,, ,, Sheet	per ton	£19	£19	..
m Manganin Wire No. 28	per lb.	8/-	8/-	..
g Mercury	per bot.	£9 2 6	£9	2s. 6d. inc.
d Mica (in original cases), small ..	per lb.	3d. to 9d.	3d. to 9d.	..
d ,, ,, ,, medium	per lb.	1/9 to 2/9	1/9 to 2/9	..
d ,, ,, ,, large ..	per lb.	3/3 to 7/3	3/3 to 7/3	..
p Phosphor Bronze, plain castings	per lb.	1/1 to 1/4	1/1 to 1/4	..
p ,, rolled bars & rods	per lb.	1/1 to 1/4	1/1 to 1/4	..
p ,, ,, strip & sheet	per lb.	From 1/3	From 1/3	..
o Platinum	per oz.	£3 18 6	£3 18 6	..
p Silicium Bronze Wire	per lb.	10½d. to 1/1	10½d. to 1/1	..
i Steel, Magnet, acc'd'ng to desc'p'n	per ton	From £15 to £40		..
i ,, ,, in bars		£58	£58	..
g Tin, block	per ton	£133 to £140	£135	£3 inc.
g ,, foil	per lb.	2/-	2/-	..
n ,, wire, Nos. 1 to 16	per lb.	1/9	1/9	..
p White Anti-friction Metals — "White Ant" brand	per ton	£40 to £70	£40 to £70	..
j Yarns, Cotton, Single 10lb. b'ndl's	per lb.	9½d.	9½d.	..
j ,, Best Flax, 6 lea.	per lb.	6d.	6d.	..
j ,, Hemp, 3 ply 10 lbs. ..	per lb.	4½d.	4½d.	..
j ,, ,, Russian, 10 lbs. ..	per lb.	5½d.	5½d.	..
j ,, Jute, 180 lbs. rove ..	per ton	£14 10	£14 10	..
k Zinc, Sh't. (Vielle Montagne ord.)	per ton	£24 5 nett.	£24 5 nett	..

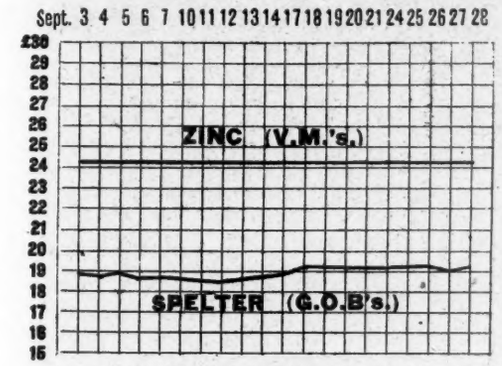
Quotations supplied by { *a* Messrs. G. Boor & Co. *b* The British Aluminium Co., Ltd. *c* Messrs. Thos. Bolton & Sons. *d* Messrs. F. Wiggins & Sons. *e* Messrs. Frederick Smith & Co.

Quotations supplied by { *f* India-Rubber, G.-P. and Teleg. Works *g* Messrs. James & Shakspeare. [Co., Ltd. *h* Messrs. Jackson & Till. *i* Messrs. Bolling & Lowe. *j* Messrs. Henry C. Yeo & Co.

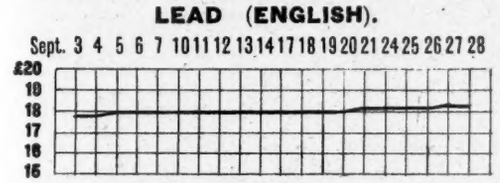
Quotations supplied by { *k* Messrs. Morris Ashby, Limited. *m* Messrs. W. T. Glover & Co., Ltd. *n* Messrs. P. Ormiston & Sons. *o* Messrs. Johnson, Matthey & Co., Ltd. *p* The Phosphor Bronze Company, Ltd.

* Subject to Founders Shares. Quotations on Liverpool Stock Exchange.
‡ Unless otherwise stated all shares are fully paid. ‖ Dividends paid in deferred share warrants, profits being used as capital.
Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

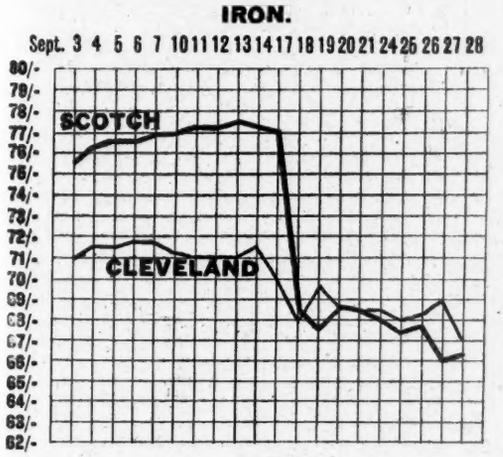
METAL MARKET.—Fluctuations in September.



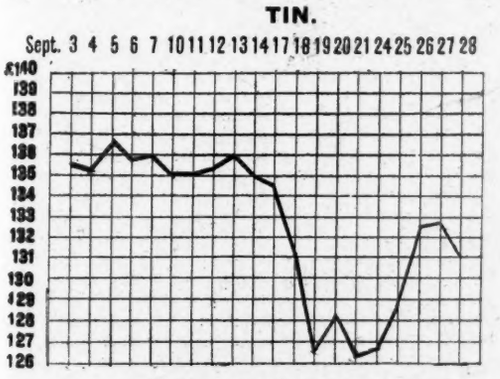
LEAD (ENGLISH).



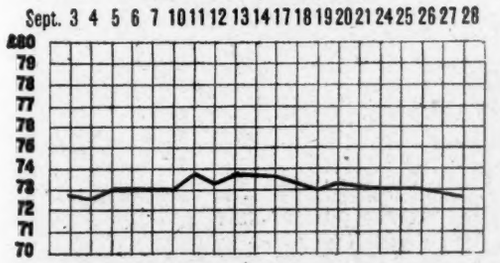
IRON.



TIN.



COPPER (G.M.B's.)



Brisbane.—A poll of ratepayers has decided against the City Council carrying out the proposed lighting of Brisbane by electricity.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE, BRADFORD 1900.

SMALL SCREW GAUGE.

Report of the Committee, consisting of Sir W. H. Preece (chairman), Lord Kelvin, Sir F. J. Bramwell, Sir H. Trueman Wood, Major-Gen. Webber, Col. Watkin, Messrs. R. E. Crompton, A. Stroh, A. Le Neve Foster, C. J. Hewitt, G. K. B. Elphinstone, E. Rigg, C. V. Boys, J. Marshall Gorham, and W. A. Price (secretary), appointed for the purpose of considering whether the British Association form of thread for small screws should be modified, and if so, in what direction. Drawn up by the secretary.

(*Section G, September 11th.*)

This Committee was appointed at the Ipswich meeting of the British Association in 1895 to consider repeated complaints that screws of the British Association thread, proposed by the Committee of 1882, obtained commercially, were not satisfactorily interchangeable. It was evident that the difficulty arose from the want of proper gauges, or other ready means of testing screw threads, and the Committee at once took steps to find out how these could be obtained. In a report presented at the Dover meeting of the Association last year (1899) were described the efforts we had made to secure the production of these gauges, and to make them generally available in a commercial way. We reported that a high degree of accuracy in dimensions, though not in form, had been attained in a small number of specimens submitted to us by the Pratt & Whitney Company; that these were the product of exceptional skill and care, and that they were only obtained after long delay. These gauges were sufficiently good for all practical requirements, and had gauges of the same character been generally available some years before, it is probable that the complaints which led to the appointment of this Committee would never have been made. Taking into consideration the difficulty that had been met in obtaining these gauges, the representations made by the manufacturers of the difficulty in producing them, and of the comparative ease with which a flat-topped thread can be accurately formed, and the fact that such screws are used in foreign countries for the best class of engineering work, we reported that the form of the British Association thread was unsatisfactory, and recommended that the Committee should be reappointed to consider its modification.

A proposal to alter the form of an established and generally satisfactory system of screw threads may cause some apprehension among users of them, and the Committee, many members of which are intimately acquainted with the trouble and inconvenience incidental to a change of the kind, recognise that very substantial reasons are required to justify it. They think it desirable that the considerations which have led them to make this proposal should be fully stated.

Consideration of the exact cause of the difficulty found in the construction of gauges for the British Association thread showed immediately that it was due to the rounded top and bottom of the thread. There is no difficulty in making any given angle between the straight portions or sides of the generating tool or chaser, but to arrange that these straight lines shall, at definite points, turn smoothly into circular arcs of a given radius is a matter of some difficulty. The difficulty has been met with a good deal of success. The original threads, cut by Mr. Lehmann, and those produced recently by the Pratt & Whitney Company, are admirable specimens of workmanship, especially when the small size of the pieces is considered, and to the careful work done by Mr. Lehmann in the years following 1882, when originating the threads, the success they have achieved is largely due. The production, however, of chasers, even if it can be repeated indefinitely, does not end the difficulty. The hardening of the screws produced by these tools introduces some inaccuracy. They are no longer perfectly straight, perfectly cylindrical, or of perfectly accurate pitch, and the only way to correct them is by grinding. The inaccuracies produced by hardening are not of sufficient importance to affect the use of taps, and in the case of die plates, the errors produced in the diameters are corrected by opening or closing the die; but for gauges corresponding to modern ideas of mechanical accuracy, the errors produced by hardening are considerable, and much greater than those found in screws whose forms can be finally obtained by grinding. With the British Association thread this process does not seem to be practicable, except perhaps in single specimens, and in this lies the inherent defect of the thread.

A way out of the difficulty is offered by the adoption of a flat-topped thread, but before this can be discussed it is necessary to consider what are the peculiar advantages of the rounded thread, which have brought it into general use, and led to its adoption by the original Committee. The British Association thread was taken, with a slight modification, directly from Prof. Thury's Swiss system, which had been constructed by finding a formula to represent the average existing practice among Swiss clockmakers. Sir Joseph Whitworth formed his system of screws in a similar way, by averaging the English engineering practice of his time. It appears that the object in view in both these cases was to regularise existing practice, not to effect a reform, and that an alteration in the form of thread in common use was not contemplated. The same was done in America for the United States thread, so far as the pitches and diameters were concerned, but the form of the thread was determined by Dr. Sellers on general considerations. The origin of the round thread in the British Association system was in the common practice of the Swiss workshops when the rule was constructed. Now, whatever may be the prescribed shape of the thread, it is

certain that small screws, produced on screw machines, will have rounded tops, and if a new rule for American threads were constructed from the shapes of ordinary small screws found in the United States, the form obtained would have a rounded top, notwithstanding that they are all supposed to represent the flat-topped Sellers thread. Since a screw machine tends to produce rounded threads, and the natural course of trade conditions tends to the reproduction of current forms, the common use in Switzerland of screws with rounded threads does not necessarily show that such a form has especial merit, or had originally been deliberately designed. It may be only the result of working conditions. Prof. Thury, in defining his thread, chose a form which could be easily produced with fair accuracy, is perfectly efficient, and can be conformed to in practice, but we venture to think it fails to meet other important conditions.

To ascertain the conditions which should determine the form of a screw thread, consider the mode of action of a screw holding two pieces together. In fig. 1 the screw serves to hold the plate, A, to the solid part, B, and a small part of the thread is drawn on a larger scale below. The action of the screw depends on the tensile strain due to the pressure produced over the surfaces *a a*, *a a*, ..., and the compression produced there by the act of screwing up relieves any pressure over the surfaces *b b*, *b b*, ... Contact and pressure at the points *c c c*, ... depend on the relative diameters of the screw and the tapped hole. The spaces shown in figure along the surfaces *b b*, *b b*, ... are, of course, greater than would occur in a well-fitted screw. Now, if the thread may

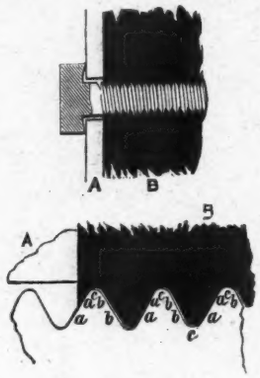


Fig. 1.

be looked upon merely as a means of supporting the tensional strain on the bolt, without offering much frictional resistance to screwing up, it is clear that this will be most efficiently done if the pressure is evenly supported over the whole of the working surface of the thread *a a*, *a a*, ..., and within the assigned dimensions of the thread this surface should be as large as possible. Contact and pressure at the points *c c*, ... depending on the respective diameters of the screw and the tapped hole may interfere with the fair contact of the working surfaces, involve extra resistances to screwing up, and, so far as the support of the tensional strain is concerned, serve no useful purpose. The best design for the thread in view of its function of supporting the tension is that which secures most perfectly a continuous working contact over the surface *a a*, *a a*, ..., and freedom from pressure at other points. These conditions are met best by a thread having straight sides, a flat top, and a clearance space at the top and bottom of the thread, such as is shown in fig. 2. The provision of straight sides gives a form to the originating tool which can be produced with more ease and accuracy than one of a curved form, and assists to secure correspondence between the surfaces of the screw and nut: the provision of a flat top gives the largest possible area to the working surface within the given limits of the thread; the provision of a clearance space at top and bottom removes the possibility of any interference with the fit of the working surface by irregularities of form at those points, and avoids unnecessary friction. Screws with straight sides and flat tops are perfectly satisfactory in instrument practice, are employed in France and Germany for the most important engineering work, and are universal in America for work of all kinds, for instrument work as well as heavy engineering work. We understand that the provision of clearance is well recognised in the practice of American and French engineers, who use the Sellers thread, and Mr. Hewitt, at Prescot, gives a very liberal clearance in the screws manufactured by him. The ease with which such threads are originated is a point in their favour, though it would be of small importance if it were shown that the thread is practically defective in other ways.

As regards the reduction of the sectional area of the core by the proposed deepening of the thread, the figures obtained by Messrs. Gorham & Price, corroborated by common experience, show that screws give way under tension by breaking across the core rather than by stripping their threads or those of the nuts, and it has been urged against the proposal to deepen the thread, that it weakens the screw in its already weakest part. The reply to this is, that the strength of the screw is really determined by the strength of the core, and that the British Association series is so closely spaced, that a screw can always be found whose core is of the required size. Moreover, in well-designed work, screws have so large a factor of safety that a reduction of the section of the core by an amount, varying from 8 per cent. in large screws, to 12 per cent. in small screws, will not generally be a matter of great importance, though it will be remembered that the resistance to torsional fracture varies inversely as the square of the sectional area.

The adoption of a flat-topped thread with a clearance would, we believe, completely obviate the difficulty of producing satisfactory gauges, the question to which the attention of this Committee was originally directed. The construction of these is referred to later in the report. Other elements of the screw have received the attention of the Committee, as follows:—

Mr. George M. Bond, of the Pratt & Whitney Company, has expressed to the Committee a strong opinion that the angle of 60° employed in the Sellers thread is most suitable for screws because of the ease with which it is formed. Tools can be ground without difficulty, and with great accuracy, to any desired angle, and Mr. Bond's reason appears to the Committee insufficient of itself to justify a change in practice. Considering, however, the extent to which screws of the Sellers form are employed in foreign engineering work, the Committee desired to obtain some evidence of the exact value of the particular angle of 60°, since if this angle were found to possess a great advantage over the angle of 47½°, the adoption of the Sellers thread would have the additional recommendation of bringing the small screw practice into line with an already extensive engineering practice, while giving effect to the conclusions already reached by the Committee of the desirability of clearance and a flat-topped thread. Some experiments on lines suggested by Mr. Crompton have been carried out by Messrs. J. Marshall Gorham and W. A. Price, and their results are printed as an appendix to this report. They concluded that an angle of 47½° is better for screws than an angle of 60°, on the ground that it offers much less frictional resistance to screwing and unscrewing on a given tensional load, and the general tendency of this observation is corroborated by the practice of using a thread for the leading screws of lathes, the screws of carpenters' clamps, and of screw jacks, in which the working surface is perpendicular to the axis of the screw. Another consideration leads us to think it undesirable to adopt an angle of 60°. The advantage of bringing small screw practice into line with that of foreign engineers will only be fully gained if their rule for the size of the flat top of the thread is also adopted. This rule gives a maximum possible clearance of ·108 pitch when the thread is cut to a perfectly sharp V at the bottom. This clearance would be sufficient, but tools with perfectly sharp points are maintained with difficulty, and it would not generally obtain. A tool of 47½°, ground to give a clearance of ·1 of the pitch, has a flat at the point ⅛th of the pitch wide. For small screws, Prof. Thury's angle of 47½° had the same sanction of practice among clockmakers as a larger angle had among engineers when it was adopted by Dr. Sellers, and though it is often difficult to assign exact reasons for the particular practice of practical men, yet it cannot be disregarded unless the reasons for its use are quite clear and are shown to be insufficient. We see no sufficient reason to change the present angle of 47½°, especially as a change of angle would make existing stocks and tools altogether useless in conjunction with the existing form.

The existing series of pitches and diameters with their designating numbers is generally approved, and the Committee has received no suggestion that it is otherwise than satisfactory.

Thus far it has been assumed that, given the necessary tools, all forms of thread can be produced with the same ease. This, however, does not apply to the small screws used in watches, which are produced by turning the blanks into a hard die without cutting edges. In such a process great force would be required either to squeeze the metal into sharp re-entrant angles, or to make it flow past sharp corners. On this point Mr. C. F. Hewitt writes to the Committee respecting the proposed alteration of the British Association thread:—"A die of this operating character for screws flatted top and bottom soon loses its contour, and needs constant replacement; and, in addition, my experience leads me to believe that it requires more force than a rounded thread, therefore it sets up more torsional strain of the metal—a factor of great moment where such small diameters are being produced, breakage in the dies being a constant source of trouble even at the best." In the same letter Mr. Hewitt explicitly approves of the proposals of the Committee for the larger threads, both as regards the flat top and the provision of clearance. Mr. Hewitt's experience at the Prescot watch factory is so large, and his knowledge of the manufacture of watchmakers' screws is so intimate, that the other members of the Committee have

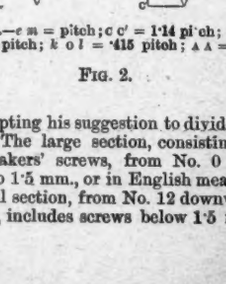


Table of Dimensions.—c m = pitch; c c′ = 1·14 pitch; d d′ = ·8 pitch; e e′ = ·8 pitch; b o a′ = ·655 pitch; k o l = ·415 pitch; a a = ·149 pitch; e e = ·238 pitch; r = ·182 pitch.

Fig. 2.

no hesitation in accepting his suggestion to divide the present series into two sections. The large section, consisting of what may be called instrument makers' screws, from No. 0 to No. 11, includes screws from 6 mm. to 1·5 mm., or in English measure from ¼ inch to ·059 inch. The small section, from No. 12 downwards, consisting of watchmakers' screws, includes screws below 1·5 mm., or, in English

measure, below ·059 inch. The Committee propose to modify the form of thread of the screw of the large section only.

The above considerations lead the Committee to propose to replace the present form of thread of screws from No. 0 to No. 11, inclusive, by the form shown in fig. 2.

Here the line A′ A A . . . represents the outline of the nut, B′ B B, . . . of the screw; and *d e f* . . . is the outline of the present British Association thread. It will be observed that the first part of the side, or the working surface, is increased by nearly 60 per cent. Accurately formed screws of this pattern for special purposes can be cut on the lathe with much greater ease than those with a rounded thread. The screw is cut with a single point tool from a cylinder, and in the larger sizes the nut can be cut with a single point tool from a cylindrical hole. The difficulty of forming chasers of a complicated form is entirely avoided. These observations apply equally to the construction of taps and plates, and of gauge pieces. Given that the pitch of the screw and the angle of the thread are accurate, and the sides straight, the fit of the screw in a correct gauge is determined by the length of the diametral line terminated by the inclined sides of the thread, and this dimension is called *the effective diameter of the screw*. If this dimension is the same in the screw and the nut they will fit without shake independently of the exact values of the external and internal diameters, or of the exact form of the ends; and the lengths of the effective diameters of screws and nuts are definite numerical measures of their fits with one another. The point which it is important should be right is the straight between A′ and B in both nut and screw. The nut must not pass A′, nor the screw pass B; but so long as the nut is cut as far as B or farther the shape of the excess does not matter. The same thing holds with the screw at A′, but here excessive clearance is objectionable because it weakens the core of the screw.

(*To be continued.*)

POWER GENERATION: COMPARATIVE COST BY THE STEAM ENGINE, WATER TURBINE, AND GAS ENGINE.*

By JOHN B. C. KERSHAW, F.I.C.

(*Concluded from page* 499.)

III.—Gas Power.

1. By use of gas engines and Mond's latest form of producer, 23·8 per cent. of the energy of bituminous coal can be converted into mechanical energy. The actual figures for a 25-H.P. Crossley gas engine, are 2,166 H.P.-hours per ton fuel.—(*Proc. Inst. Civil Engineers*, March, 1897.)

2. Statement by Dr. Bowman that with gas engines of best type, 1 lb. coal yields 1 H.P.-hour. With a 300-H.P. plant the H.P.-year (apparently of 2,825 hours.), costs only 30s. The capital outlay per H.P. for producers and engines is £12, or 20 per cent. higher than with a modern steam plant, but the thermal efficiency is 50 per cent. greater.—(*Journal Soc. Chem. Industry*, December, 1897.)

3. At Lausanne, in Switzerland, a 390-H.P. gas engine plant has run satisfactorily for over two years, for supply of the electric power to the tramway system. The plant consists of three 130-H.P. Crossley engines, working with an expenditure of 1·137 lbs. coal per H.P.-hour.—(Electrical Review, November 11th, 1898.)

4. Statement by Dowson that at Halifax the consumption of fuel is 1·01 lbs. per H.P.-hour.—(*Mech. Engineer*, 1898, p. 703.)

5. Statement that by Thwaite-Gardner system of utilising waste gases of blast furnaces, 1 I.H.P.-hour is obtained per 1·3 lbs. coke charged into furnace.—(Electrical Review (London), December 30th, 1898.)

6. Results of trials of above system at Wishaw Iron Works, Glasgow. 10 H.P. can be obtained per ton of fuel charged into furnaces per week (6 × 24 hours).—(Electrical Review (London), May 6th, 1898.)

7. Results of tests by Prof. Meyer of 60-H.P. gas engine at Differdingen, run on blast furnace gases. Thermal efficiency varied between 27·4 per cent. and 30·2 per cent.—(Abstracted, *Engineering Magazine*, July, 1899.)

8. A 1,500-H.P. Westinghouse gas engine, now building, is expected to develop a thermal efficiency of 30 per cent., or 1 B.H.P. per lb. of coal charged into the producer.—(Electrical Review (London), July 28th, 1899.)

9. At Northwich a 300-H.P. gas engine has been running on producer gas for a considerable period, and yielding 1 brake H.P. per lb. coal charged.—(*Journal Soc. Chem. Industry*, July, 1899.)

10. Meyer has estimated that in Germany, using blast furnace gases, the H.P. hour could be generated at a cost of ·699 pfg.—(*Rev. Universelle des Mines*, July, 1899.)

11. Lencauchez has estimated that using producer gas generated from French anthracite coal, 1-H.P. hour would cost ·0163 franc.—(*Journal de Soc. des Ingenieurs de France*, 1899.)

12. Estimate by Humphreys of cost of E.H.P.-hour, using Mond producer gas, based upon a plant of 10,000 H.P. = 7,000 E.H.P. Capital expenditure estimated to be £140,000, and total running expenses, £35,000. Interest taken at 8 per cent.—(*Proc. Inst. Civil Engineers*, March, 1897.)

Converting these data into comparable form, and gathering the results together, we have the figures presented in Tables V. and VI.

Table V.—Fuel Consumption of Gas Engine Plants.

Place.	lbs. fuel per H.P.-hour.	Authority.	Reference No.
Pittsburg ...	1·00	Westinghouse Engineers	8
	1·00	Dr. Bowman	2
Northwich ...	1·00	Beilby	9
Halifax ...	1·01	Dowson	4
	1·03	Humphreys	1
Lausanne ...	1·137	... ...	3
	1·300*	Thwaite	5
Glasgow ...	1·555*	Booth	6

* These refer to coke and blast furnace gases.

Table VI.—Estimated Costs of the E.H.P.-Year of 8,760 Hours when Generated by Gas Power.

Authority.	Cost.	Remarks.	Reference No.
Meyer ...	£4 1 7	Blast furnace gases	10
Humphreys	5 0 0	Mond producer gas	12
Bowman ...	6 2 0	" "	2
Lencauchez	7 12 2	French anthracite used in gas producer	11

IV.—Conclusion.

Taking the best figures for each of the three sources of power dealt with above and bringing them all to a common basis of comparison, namely, the cost of the E.H.P.-year of 8,760 hours, we obtain the figures given in Table VII.

Table VII.—Comparative Costs of Electrical Power. Lowest Recorded Costs per E.H.P.-year of 8,760 Hours.

Source of power.	Lowest estimated cost.	Country.	Lowest actual cost.	Country.
Water	£1 5 5	Canada	£1 19 0	Switzerland
Steam	4 18 8	England	4 17 7	U. States
Gas (blast furnace)	4 1 7	Germany	...	...
Gas (producer) ...	5 0 0	England	...	...

The first cost for water-power given in Table IV. has not been used in Table VII., since it is evidently exceptional, and there is no probability of power being generated from water in large units at such a low cost.

The figures in Table VII. support the opinion, now generally held, that water, when developed without excessive capital expenditure, is the cheapest source of mechanical or electrical energy. When, however, the hydraulic engineering expenditure has been heavy, or when the power after generation has required to be transmitted over long distances, the margin between the relative costs of water and steam-power is greatly narrowed, and in some cases disappears altogether.

Electrical energy, generated by falling water, is costing more at Rheinfelden, at Zurich, and at Buffalo, than it would cost in South Lancashire, if generated by steam-power in large units, and the margin between the actual charge for water-power at Niagara, and the estimated cost of steam-power in large generating stations in South Lancashire, is only 12s. 1d. *per E.H.P.-year.*

With regard to the influence of capital expenditure occasioned by heavy engineering work upon the final cost of water-power, it is probable that the differences in the charges for the E.H.P.-year at Niagara, Rheinfelden, and Lachine Rapids, are to be ascribed to this cause; though in the case of Niagara, heavy promotion expenses were no doubt incurred.

The power at Lachine rapids and Massena will be developed with a much lower capital outlay per H.P. than has been the case at Niagara and Rheinfelden; but the figures for the two former stations are not yet complete, and possibly the estimates of the sale price of the power—namely £1 5s. 5d., and £2 10s. per E.H.P.-year, will have to be revised.

Turning now to a consideration of the relative position of gas power, the question of the practicability of large engines may be taken as settled; but until further experience has been gained with these large engines under constant work, it is unsafe to prophesy upon the place they will occupy in the future industrial development of this and other countries.

If they do not cost excessive sums for maintenance and repairs, large gas engines—in conjunction with coke ovens and blast

* Read before Section G of the British Association, September 7th, 1900.

furnaces—may entirely alter the present position of affairs; and new industries which at present are being established in the neighbourhood of water-power stations, may find themselves in severe competition with similar manufactures carried on in the coal and iron districts of the older manufacturing countries.

It has been calculated that 2,000,000 H.P. is annually wasted in the gases issuing from the blast furnaces of the United Kingdom.* If these waste gases could be industrially utilised in the manner suggested, we should to a large extent be compensated for our lack of natural water-power.

But blast furnaces demand coke, and coal beds are exhaustible; so that even if this source of mechanical and electrical energy be tapped, it can only postpone, but not avert, the final triumph of the waterfall and of the turbine.

Discussion.

Mr. Alex. Siemens (who presided in the absence of Sir Alex. Binnie) said that this was a large subject, and it was very difficult to discuss a paper like that unless they had brought the statistics with them bearing on the various costs. He called attention to one point which Mr. Kershaw had thought of, but which was usually overlooked, and that was the fallacy that people talked about water-power running to waste in England, while abroad it was being used. That was absolutely not the case. The fact that water-power was utilised at Niagara and in Switzerland—and mind that in South Lancashire the power could be generated cheaper by steam—was simply due to the fact that in all cases the natural supply of water was inexhaustible, and was pretty constant all the year round. In England water-power was very different between the dry and wet seasons. Any attempt to store water in the wet season for the dry season led to the excessive capital expenditure of which the author spoke, and which made it so difficult to utilise the water-power to the same extent as had been done abroad.

Mr. Sydney F. Walker said that Mr. Kershaw had put in a concrete form a lot of material scattered through many periodicals, and engineers' time was limited, so that it was a very useful thing to have all that information put into a handy form. There had been a good deal said lately about the exhaustion of the coal beds. Everybody agreed that it was not coming to pass in our day nor in the days of our children, but possibly it would come to pass in the days of their children. The question was if we were to maintain our manufacturing supremacy—it was threatened in various ways from other sources—what was to happen next? They must put something in the place of the coal which had given them their manufacturing supremacy in the past. If they looked back they would see that the whole question of manufacturing was revolutionised by the economical transmission of electricity. If they went far enough back they would find water-power was the only possible means of mill driving, and the mill was obliged to be placed upon a creek or stream where the water could be used handily. When coal was discovered the factories were put down in the neighbourhood of the coal beds. After the development of railways they were put down conveniently handy to the railways, and practically the arrangement of the railways ruled the success of manufacturing. The question was now altered. They could generate their power, transmit it economically where they pleased, and they might use it where it was convenient, but what should the power be? Mr. Kershaw had mentioned two sources of power which he (Mr. Walker) thought they would have to use in the future. One was the enormous power going to waste in blast furnaces, and the other was water. They had to look forward to the fact, which he had mentioned, that, simultaneously with the exhaustion of the coal beds, the present system of manufacturing iron would disappear; and they had also to look at another thing—they knew (those of them who were studying the question) that it was quite on the cards that the present system of manufacturing iron would disappear, and that it would be manufactured electrically. The source of electricity might be any source of power they might please. They came, now, to the only sources they had left—water, wind, and anything else that happened—but principally water and wind. They had done a very great service by clearing the ground from that romantic idea that water-power was got for nothing. "Water is got for nothing; Nature happened to make a fall at a particular place, and if they could use that fall without spending any money on it they had their water for nothing." But they could not. They had to spend money to utilise that water. It was an instructive thing to find that the cost of power in Switzerland, where they had not any coal, was less than the estimated cost at which they were going to generate current in Lancashire. They were bound, in studying the question, to recognise the fact that what the water did, and the only thing it did—he would be glad to be corrected if wrong—was to displace the coal. Unless they could get down to the same cost, or below it, they were not going to do any good with water-power. The question had to be carried, he thought, a bit further. They would have to come to water-power if they were denuded of their coal beds, and they would have to look round, and it appeared to him that they must not wait for nature. Nature had made waterfalls thousands of years ago in the same way that it had made the coal beds. They must not wait for nature, they must do what the waterworks engineers had done, and he thought the experience they had gained would be of enormous value when they came to seriously tackle the problem of furnishing power by means of water, and transmitting it by means of electricity. Sitting in that section on the previous day when Mr. Watson read his paper on the Bradford Waterworks, he calculated roughly that the power which was transmitted by the water coming into Bradford would give him something like 15,000 H.P. for an 8-hour day, or put into another form, for the Bradford electric lighting station day, he might have half a million of 8-C.P. lamps. There were difficulties in the way of doing that which he need not enter into except to say that the difficulties would have been overcome if the waterworks engineer had had to overcome them. The waterworks engineer had only to consider one thing at the present time. He had to deliver a certain quantity of pure water, and that was all he cared about, but if he had to take the power from it he could do so, and still deliver the quantity. That was a partial solution of the problem. The other part he thought Dr. Lodge reckoned in connection with lightning conductors—the geological strata would have to be studied carefully, and the whole question threshed out.

Major-General Webber said that it was very wholesome for motive-power engineers and engineers of stationary generating stations for making electricity, to be reminded from time to time that they had overlooked what was clearly demonstrated in 1881 at Paris—that was, the cost of generating electricity by means of gas engines worked with generator gas. It was quite true that the plant then exhibited under the gallery was a very small one, but it was also quite true that since then engines had been introduced which could use generator gas which cost certainly under 1½ lbs. of fuel per KW.-hour, manufactured at the terminals of the dynamo. Anyone with any experience in the generation and sale of electricity knew that that figure was from 3 to 6 lbs. of coal in their generating station. Hardly any large electric generating stations in which gas engines were using generator gas were employed, notwithstanding the great economy in the consumption of fuel.

Mr. Siemens presented the thanks of the section to Mr. Kershaw.

* Electrical Review, May 6th, 1898.

PROGRESS IN ARC LIGHTING BY ALTERNATING CURRENT LAMPS.*

By H. W. HILLMAN.

At your last meeting, held in Cleveland, in August, 1899, one of the most important discussions was on the subject of illumination by alternating current arc lamps, and, until recently, this subject has always appeared to include a difficult problem. We can all remember the illumination test which was conducted by the local company on the first day of your convention at Cleveland. That test demonstrated that the light from the alternating lamp properly constructed is satisfactory in all respects to the public, city authorities and central station managers.

A few months later, the Georgia Electric Light Company of Atlanta installed a circuit of alternating lamps for the purpose of making a comparison in the matter of light with their 10-ampere open arcs. After three months' operation, a formal inspection was made by the city authorities and representatives of the lighting company, with the result that the light from the alternating lamps was not only greatly favoured, but the alternating system was adopted for illuminating the streets of Atlanta. Such experience, together with results of many other tests, encourages us to believe that so far as the subject of light is concerned, arc lighting by alternating lamps has made considerable progress in the last 12 months. Much has been said about the large installations, such as Hartford, Woburn and other stations, which are operating several hundred arc lamps.

It is interesting to dwell for a moment on some of the features in connection with the new arc system of a small electric lighting plant. The Fort Plain Gas and Electric Company of Fort Plain, N.Y., has furnished commercial and street lighting for the last 12 years. The old equipment consisted of a high-frequency alternator with belt-driven arc machines. About a year ago a series alternating system, with one 50-light transformer, one 25-light transformer, 42 arc lamps and 45 100-C.P. incandescent lamps was introduced. The service is two-phase, a transformer being installed on each of the phases. Notwithstanding that one is a 50-light and the other a 25-light transformer, the two phases are balanced on the commercial circuits within three volts. The system has been operated for about 12 months, without any expense whatever for repairs. Only a half day, once a week, is required to trim the lamps. The space occupied at the station for the arc-lighting system is only 4 by 15 feet. Notwithstanding that the primary voltage from the transmission line is quite variable, the current of the arc system remains perfectly steady, because of the excellent regulation of the transformers. Fig. 1 illustrates a simple arrangement for automatically switching off the lamps at daybreak. A battery circuit energizes two magnets—the circuit being closed at the proper time by an ordinary alarm clock. When these magnets are energized, a weight is released, which opens the primary switches of both transformers, thus opening the street-lighting circuits. As current is taken from a distance, and there is no generator in the station to require attention, the device referred to above makes it unnecessary to have any attendance

* Read before the Ohio Electric Light Association, at Toledo, O., August 16th, 1900.

whatever at the station. The arrangement has been in service for more than a year and has never yet failed to operate.

Referring further to small stations, the series alternating system offers wonderful flexibility for arc lighting. Notwithstanding the comparatively small size, a 25-light transformer has an efficiency of 95 per cent. The transformers are also made for 35, 50 and 75 lights.

A station manager was recently considering a system for 200 lamps, and desired sufficient spare capacity for 225 lights. At first glance two 100-light transformers and a 25-light size would be

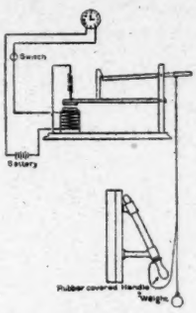


Fig. 1.—Automatic Switch for Opening Circuit.

suggested, but the conditions of load, as well as the size of the circuits, led to an arrangement of three 75-light transformers. For a time each transformer will be operated with about 65 to 70 lamps, and the multi-circuit arrangement employed for operating two circuits of 35 to 37 lamps each.

Station practice frequently requires the adoption of a transformer to operate at half load temporarily, and later to be connected for the full rated capacity. The constant-current transformer possesses an advantage in this respect, as the primary coils may be connected so as to operate at half load with practically full-load power factor and efficiency. (See fig. 2.)

The question has been frequently asked if the transformers can be operated on two and three-phase circuits. Many such systems are now in actual use, and are operating satisfactorily. Of course, great care should be exercised in the installation, with a view to properly

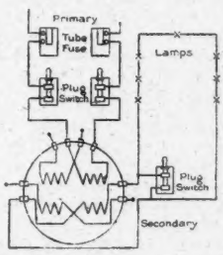


Fig. 2.—Connections for Constant-current Transformer.

balancing the system. Occasionally it happens that only two transformers are wanted, and they are for use on a three-phase service. In such cases a special primary winding can be furnished for a regular three to two-phase transformation. Fig. 3 shows the connections of two constant-current transformers for balancing the load on a three-phase circuit. Fig. 4 indicates the connections of the

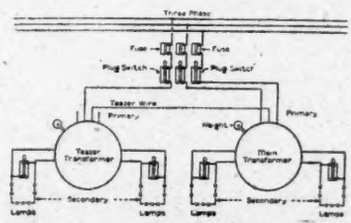


Fig. 3.—Connections of Two Constant-current Transformers for Balancing Load on Three-phase Circuit.

same transformers operating as single-phase transformers on a three-phase circuit.

Perhaps some of the Ohio stations are so situated that economy in space would be an attractive feature. The accompanying illustration (fig. 5) shows a modern arc plant where six 50-light transformers, with an aggregate capacity of 300 lights, require but 140 square feet of floor space at the station, or an equipment of less than half a square foot per lamp. The old arc-lighting system demanded 1,400 square feet for only 225-light capacity. The economy in space is in the ratio of 10 to 1, without considering 75 additional lamps, which the plant is now capable of operating.

There exists a universal appreciation of the saving due to the lower maintenance cost of the enclosed arcs compared with open arcs, but insufficient attention seems to have been given to the higher efficiency which the series alternating system possesses. It is interesting to consider a 300-light arc system where a large alternator is used for operating incandescent lamps, commercial arcs, and the series alternating system. Considering that after 11 or 12 o'clock at night the street lighting would represent most of the load, the

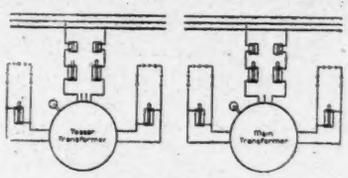


Fig. 4.—Constant Current Transformers Operating as Single-Phase Transformers on a Three-Phase Circuit.

alternator and constant-current transformers would have an average net efficiency of from 85 per cent. to 90 per cent. Comparing this with the efficiency of the old-style arc machines, operating from line shafting, it is invariably found that there is a saving of approximately 200 watts per lamp. Operating 4,000 hours per year, the saving represents 800 kilowatt-hours per lamp per year, and at the low cost of one cent per kilowatt-hour for energy, a net saving is effected equivalent to $8 per lamp per year. If representatives of some of the larger Ohio stations should feel one cent per kilowatt-hour is too high, let them use one-half cent, and there still remains a saving of $4 per lamp per year, due to the high efficiency of the series alternating street system.

The small maintenance cost for operating enclosed arcs is beginning to be appreciated. A report from a station where a 100-light transformer and 100 lamps are operated for over a year states that not a cent has been expended for parts for either the transformers or the lamps. A report on six transformers in operation for more

Fig. 5.—A Modern Transformer Plant.

than two years shows that the only expense for maintenance has been a small chain, costing not more than 10 or 15 cents. The exact annual cost of operating enclosed and open arc lamps has been frequently discussed. The table below may be considered as representative of the annual saving in maintenance, in connection with a station having established a first-class arc lamp department:—

Items.	Open arcs.	Enclosed arcs.
Trimming	$5.63	$1.28
Carbons	6.57	1.56
Inspector	.94	.90
Repairs	2.00	1.00
Inner globes	...	.60
Outer globes	.08	.14
	$15.22	$5.48
	5.48	
Annual saving in maintenance	$9.74	

It is only fair to add that in such cities as Cleveland, Chicago, Pittsburg, or Cincinnati the outer globe will require cleaning frequently, due to the excessive dirt and dust which is known to accumulate in those particular districts. This item would increase the cost of maintaining enclosed arcs, approximately, $1 per lamp per year.

Whether the station be small or large, it is equally essential that a systematic method be adopted for taking care of inner globes,

carbons, &c. As the enclosed arcs have two globes, compared with one for the open arc, additional attention must be paid to globes. The design of the enclosed lamp enables the use of the residue of the upper carbon for the lower holder, and advantage must be taken of this feature in order to operate at a low cost. Inner globes should be carefully cleaned, and the residue of upper carbons cut the proper length to be used again. Inner globes ought to be returned to the station and cleaned at each trimming, when the carbon deposit is so slight as to enable a thorough cleansing of the globe. Too much stress cannot be laid upon this point. In the globe cleaning room of a modern enclosed arc lamp department, a scheme has been adopted for brushing out the globe and cleansing it with water at the same time. An upright brush is mounted upon a supporting arm and belted to a motor. The brush is revolved at a considerable speed to remove the carbon dust from the globe, and at the same time hot or cold water is passed through pipes into the globe. A recent trial was made to see how fast the globes could be cleaned by this method. At the start the globes were in the wagon box, having been returned to the station. They were taken out, the holders removed, and in 1 hour and 20 minutes 125 inner globes were cleansed, dried, and returned to the wagon box ready for use the next day. The trimmer not only takes care of 125 lamps per day during this season of the year, but cleans the globes. A device for testing carbons for straightness, diameter, and length is provided. A gauge on the table is set for the right length, and 125 carbons may be quickly cut and placed in the holder for the next day's use.

Considering the excellent organisation of this lamp department, together with the great care which has been paid to little details, we need not be surprised to learn that the previously cited comparative statement showing cost of operating open and enclosed lamps was based on the result obtained at this station. It may serve as a guide for central station managers investigating the economy which may be secured by the enclosed arc street system.

Progress may also be noted in connection with inner globes. In the first installations of alternating enclosed lamps, it was common to use clear globes. It seemed reasonable to believe that more light could be secured from clear glass than from opal. However, the danger from this practice became apparent. A shadow existed beneath the enclosed arc lamp to a degree almost approaching that of the old style open arc. This shadow was found to be more annoying, because the arc constantly moves around the carbon, producing a wandering shadow on the ground beneath the lamp. The source of light is the arc only, when using a clear inner globe, while with the opal glass the entire globe, from the top to the base, is flooded with light; the globe itself becomes a source of light. The shadow is entirely eliminated, a beautiful diffusion is secured, and tests show that the amount of light is greater at a distance with an opal inner globe than it is from a lamp equipped with clear glass. Evidences are not lacking to prove the practicability and value of opal inner globes for enclosed arc street lighting.

I desire to earnestly appeal to the central station managers of Ohio to energetically push the arc lamp department of their business, and particularly the street lighting branch. Such wonderful strides have been made in interior lighting that this part of the arc lamp department has become a source of increasing income. In all sections of the country evidences of this fact are abundant.

The street lighting end, however, has been lax. Particularly is this true where stations are furnishing lights from the old-style arc system. There is no more reason to expect to energetically push street lighting and greatly increase your income with the old-style system than there was for competing with Welsbachs and pleasing the merchants, when you had only open arcs available for store lighting. As soon as the merchants saw the great improvement in artificial light, they adopted it exclusively. They had become accustomed to the use of electric light in great abundance, because it is a superior illuminant.

The same argument applies in connection with street lighting. The alderman, who has recently moved into the new residential district, takes pride in referring to the new-style lamps. They harmonise with the residences recently built. They go hand in hand with the new railway line, which has just been extended into that territory; and, altogether, the illuminating company occupies a very strong position. In introducing a new system of lighting, with the advantages of steady burning, absence of shadows, neatness of installation, cleanliness of globes, and uninterrupted service, the outlook is encouraging. All these superior features popularise the lights among the citizens of any city or town. The interest displayed in this subject by officials and representative business men is not surprising. In a city in the East, which has met with considerable success in introducing the new lighting system, the Mayor secured opinions from many prominent citizens whose business takes them on the streets at night, and whose opinions might be considered of much value. Commendatory letters were received from the chief of police, the chief of the fire department, the superintendent of the street cleaning department, the most prominent physicians, the proprietor of a prominent livery stable, and the bicycle path commissioner.

An arc lamp near a fire hydrant is of considerable value. The good illumination facilitates making connections with a hydrant, and assists the fire department in saving life and property. Such an argument should appeal to the citizens of any community. While arc lamps need not be placed at every hydrant, they should be so located that every hydrant is well illuminated, or if this is impracticable, a series incandescent lamp should be suspended over each hydrant which is not already lighted by an arc lamp.

These ideas lead us into the subject of candle-power, and strongly suggest the low energy lamps, or the lamp of smaller illuminating capacity. The minutes of your last meeting contained a few words on this subject by Mr. Hoag, city electrician of Cleveland, who stated that he hoped that the time would come when arc lamps of smaller units would be available for street use, thus affording an opportunity for installing them more freely throughout all sections of the city or town.

Progress has already been made along this line; for example, the 10-ampere open arc lamp consumes about 480 to 500 watts, while the new series alternating enclosed arc consumes only 425 watts at terminals. Among the 150 stations which have adopted the series alternating system, almost all of them are using the standard 6·6-ampere or 425-watt lamp. This shows conclusively that the low-energy lamp has come to stay, and, in fact, some of the systems installed are adjusted for six amperes and consume only 375 to 400 watts at terminals. As the energy consumed per lamp forms such a large proportion of its cost of operating, the subject becomes a very important one.

To study all the phases of the street lighting business should be the aim of every central station manager. At this time, when such a great improvement is offered for illumination, there is something wrong if the annual income from the city is not increased. The adoption of low-energy lamps will encourage the use of lights extensively; the economies effected by the new system will increase the profits materially; and, finally, as the public reaches that degree of education where artificial light will be demanded as universally in the street as it is now used among the merchants, mills and factories, your arc lamp department will be in a flourishing condition. Progress in arc lighting by enclosed lamps will have been substantiated for all time.

STEEL: ITS PROPERTIES AND TESTS.

IV.

As the chemical composition is specified there is no need to ask for tenacity or elongation, but a drop test may be fairly demanded. If chemical composition is specified and followed, the drop ought not to include a certain maximum deflection, but should specify that the rail shall not break under a single flaw. The author thinks that a specified range of 0·10 per cent. of carbon is a better and more prompt means of securing uniformity than the drop test, which is useful merely to prove ability to withstand shock. A dead-weight test is also unnecessary if the drop test is satisfactory, with satisfactory chemical tests.

The author complains that some specifications demand that a piece of rail 12 inches long must be submitted for approval before general rolling, because, he naively remarks, "Confidence can be safely placed in the skill and integrity of American manufacturers." Presumably the European railmaker may properly be asked to supply this, but the American is too skilful and honest. This is on a par with the coddling of the American manufacturer by the unpractical consultant. Now, of course, the American is neither better nor is he worse than other contractors. His business is to make money, and he generally does so.

American rails are allowed to vary $\frac{1}{4}$ inch in length and $\frac{5}{64}$ inch in height between the lowest and highest, or $\frac{1}{64}$ inch and $\frac{1}{32}$ inch above normal. It is complained that English and other European specifications are too exacting on these points, because the best American railroads allow the above variations. But the best American track is not equal to the best English, nor are chairs used. A different height matters nothing on a sleepered road. It does matter on chairs.

Inspection is another grievance. It often causes delay, and insufficient inspectors are sent to get through the work of gauging, marking, and so on.

Generally this criticism of foreign specifications is excellent from the point of view of the manufacturer. We hope it may show the American manufacturer something that he has not realised when he has talked so freely of his outputs and of the general inferiority of European products.

Above all, our own manufacturers may study its spirit with advantage. They will see the sort of easy time expected by the American manufacturer, and how he is able to kick at excessive precautions and demands. It may even cause them to combine for the purpose of a general all-round refusal to quote to the irrational specifications of non-technical and unworkmanlike engineers. The author does not appear to realise for a moment that the clauses he condemns in European specifications are those to which the "effete and wornout" rail mills of Europe have all along had to work. American rails are good and shapely, and though they may be high in phosphorus they are not, we believe, prone to break. In any case, if American rails will do for our purpose, why ask better rails from our own makers? Clearly the American makers kick at such very stringent requirements, and if all one hears be true, there are some curious facts connected with inspection at works that make one think that much of the inspection which is carried out is more or less ineffective. One of the worst evils of a too stringent specification is that it sets up a desire to get round it. The stringency defeats itself. It is to be hoped that specifications may be made more international in character in order to destroy

something of the unequal burden imposed on our own manufacturers.

In the near future we propose to give particulars of the main points in the specifications adopted by the American section of the International Association for Testing Materials.

FEED PUMP EFFICIENCIES.

Mr. Philip K. Stern, of New York City, makes some interesting observations on effecting economies in feed water systems, in the columns of the New York *Electrical World*. He remarks that he had occasion in several instances to make duty tests of the feed pumps of various isolated plants, and has obtained negative results from a standpoint of economy when comparing the merits of two methods of feeding boilers. He brings forward the matter for the benefit of engineers operating dynamos, and superintendents of electric light and power plants. Upon investigating the comparative merits of electrically operated feed pumps to those taking steam from the boilers of their plants, he has found that in most cases when small steam pumps are operating on various loads having a maximum speed of about 50 full strokes per minute, the actual steam consumption on a basis of a 2 H.P. load when operating at this speed, will be on an average of about 130 lbs. of water per horse-power per hour, but when in use feeding the boiler, the wide fluctuations in the steam consumption of the engine during the varying loads demanding more or less water than the full capacity of the pump, gives rise to considerable variations in the speed of the pump, which seriously affects its efficiency. That is, taking the duplex pump as an example, the strokes are not complete, and taking as a fair average of the pump's speed one-half of its maximum, the steam consumption of the pump would increase, in some instances to 180 or as much as 200 lbs. of steam per horse-power per hour. Therefore, he says, upon a nominal basis of feed, it would be fair to assume a steam consumption for the steam pump of 180 lbs. of water per horse-power per hour. This is what is found to be about the consumption of these small steam pumps in practice, and figuring on a basis for a boiler evaporation of 8 lbs. of water per pound of coal, such as the anthracite pea which is in common use in New York State, and particularly in New York City, which is a fair average for a 10-hour run, there results a coal consumption for 300 days of 135,000 lbs., or 62 gross tons. This would have to be charged up to the steam consumption of the pump, and, at $3.25 per gross ton, would amount to $201.50. The cost for cylinder oil for the steam end of the pump would be about $5.50, making a total of $207. Mr. Stern continues as follows:—

"A pump driven by an electric motor of about 2 H.P. capacity will have about the same friction loss in its operation in consequence of gear, &c., as the steam pump, or probably a trifle less. Allowing a total loss of 40 per cent. in the dynamo which operates the motor, the loss in the motor itself, as well as in the windings, and a steam consumption of 28 lbs. of evaporated water per horse-power per hour for the prime mover, which is a fair average of the water consumption of our modern power plants, we have a consumption of 39 lbs. of water per horse-power per hour for working the electrically-driven pump. This, on the same basis as the steam pump, would amount to 28,222½ lbs. of coal for the same time, or 13¦ gross tons, which would amount to $43.06. The lubricating expenses would be about the same for both pumps, any slight difference, however, being in favour of the electrically-driven pump.

"The steam pump would have to be charged up with an annual expense of about $5 for the steam end of the pump for repairs, which would make a total expense for maintaining the steam pump, irrespective of the investment, of about $212 annually. For the power pump the repairs would not exceed $2 per annum, which would bring the total expense up to $45, leaving a saving in favour of the power pump, omitting investment, interest, &c., of $177 on the maintenance of the pump alone.

"As there is less than one-quarter or nearly one-fifth of the amount of water evaporated in the boiler for the operation of the electrically-driven pump, there would be about one-fifth of the amount of incrustation and deposit of scale taking place in the boiler due to the excess which would be formed in consequence of operating the steam pump. Therefore, the extent to which the boiler would be depreciated by the evaporation of the water necessary to operate the prime mover at full load would be still further depreciated by the steam pump to the extent of about 10 per cent., which means, if an allowance of 10 per cent. is made for depreciation, say, on $1,000, $100 of this amount would have to be charged annually to the steam engine, and about 10 per cent. of this would have to be booked against the steam sucker, which would swell the expense of operating the steam pump annually another $100. As this is also true of the depreciation in the furnace by the use of the steam pump, we find it goes all the way back to the grate bars, smoke stack, &c.; therefore, it would be fairer to the electrically-driven pump to figure a depreciation of 10 per cent. on the whole cost of the boiler plant complete, including erection, and on the basis of a 180 or 200-H.P. boiler, including stack, setting, &c., costing about $2,300, we would have to charge up $230 annually to the engine, and 10 per cent. of this, or $23, to the feed pump. This would have to be added to the fuel expense. Thus it will be seen that the saving in the running expense of the electrically-driven pump would amount annually to $200, which sum would more than pay for a new pump.

"Of course, the same saving might be effected with an ordinary power pump taking its power from a line shafting. The difficulty with this scheme, however, would be apprehended in the regulation of the feed water. In the electrically-driven pump the feed water supply may be varied at will.

"The writer would be pleased to learn something of the experiences of other engineers in this connection, as it would appear that there is plenty of room for argument both in favour of and against the use of steam pumps as boiler feeders where electric power is accessible."

NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

NEW PATENTS, 1900.

Compiled expressly for this journal by W. P. Thompson & Co., Electrical Patent Agents, 322, High Holborn, London, W.C., and at Liverpool, Manchester, and Birmingham, to whom all inquiries should be addressed.

16,500. "An improved high voltage electric cut-out." A. Eckstein and A. J. D. Krause. Dated September 17th.

16,501. "Improvements in arc lamp suspension apparatus, applicable also to other purposes." A. Eckstein and A. E. Angold. Dated September 17th.

16,507. "Improvements in or connected with the regulation and control of electric motors." W. L. Spence and The British Electric Plant Company. Dated September 17th.

16,508. "An electric motor switch gear." J. Lenderyon and E. F. Smart. Dated September 17th.

16,528. "An automatic safety clutch and ceiling rose for electric arc lamps." E. P. Barfield. Dated September 17th.

16,534. "Manufacture of porous metal plates for electric accumulators." F. W. Buhne. Dated September 17th.

16,541. "Improvements in electric switching and metering apparatus." J. G. Lorrain. (H. A. Macdonald, France.) Dated September 17th.

16,543. "Improvements in or relating to telephonic switchboards and the like." K. N. Von Szoposi. Dated September 17th.

16,545. "Improvements in arc lamps." C. F. W. Dudding. Dated September 17th.

16,567. "Improvements in or connected with thermo-electric batteries or thermo piles." W. Buchner. Dated September 17th.

16,590. "Improved ear piece for telephone receivers." P. McLellan and T. R. Small. Dated September 18th.

16,600. "Electro-mechanical sound-augmenting apparatus applicable for use as an aid to the deaf." C. Adams-Randall. Dated September 18th.

16,644. "Improvements in electricity meters." S. Z. de Ferranti. Dated September 18th.

16,656. "Improvements in electrically-propelled motor vehicles." T. J. Ryan. Dated September 18th. (Complete.)

16,667. "Improvements in and relating to the working of electric or other tramway or railway points." W. J. Stewart. Dated September 19th.

16,696. "Improved method of treating the animal or human body by electric forces." C. M. Johnson. Dated September 19th.

16,697. "Improvements in systems of electrical distribution." The British Thomson-Houston Company, Limited. (E. W. Rice, jun., United States.) Dated September 19th. (Complete.)

16,698. "Improvements in conduit plows for electric railways." The British Thomson-Houston Company, Limited. (J. Hoffmann, United States.) Dated September 19th. (Complete.)

16,699. "Improvements in lightning arresters." The British Thomson-Houston Company, Limited. (L. Bell, United States.) Dated September 19th. (Complete.)

16,700. "Improvements in systems of electrical distribution." The British Thomson-Houston Company, Limited. (C. P. Steinmetz, United States.) Dated September 19th. (Complete.)

16,701. "Improvements in electrically-operated pumps." The British Thomson-Houston Company, Limited. (E. M. Hewlett, United States.) Dated September 19th. (Complete.)

16,702. "Improvements in dynamo-electric machines." The British Thomson-Houston Company, Limited. (E. W. Rice, jun., United States.) Dated September 19th. (Complete.)

16,703. "Improvements in controlling electric motors." The British Thomson-Houston Company, Limited. (M. W. Day, United States.) Dated September 19th. (Complete.)

16,704. "Improvements for adjusting brush holders for electric machines." The British Thomson-Houston Company, Limited. (H. G. Reist, United States.) Dated September 19th. (Complete.)

16,705. "Improvements in systems of train control for electric railways." The British Thomson-Houston Company, Limited. (C. E. Barry, United States.) Dated September 19th. (Complete.)

16,706. "Improvements in means for preventing hunting of dynamo-electric machines." The British Thomson-Houston Company, Limited. (H. W. Buck, United States.) Dated September 19th. (Complete.)

16,738. "Improved electric energy meter." F. Saldana. Dated September 19th.

16,777. "Improvements in or connected with electrically ignited motor cars, cycles, or the like, applicable for other analogous purposes." J. S. Stafford. Dated September 20th.

16,798. "Improvements in underground conduits for electric conductors." J. Zaffe. Dated September 20th. (Complete.)

16,801. "Process and apparatus for the electrolytic decomposition of alkaline salt solutions." A. J. De B. e. Cunha. Dated September 20th.

16,805. "Improvements relating to setheric signalling." H. M. Hozier. Dated September 20th.

16,808. "Improvements in and relating to the method of and apparatus for electrolytically depositing metal." R. J. Houghton and W. E. Cooke. Dated September 21st.

16,865. "Improvements in and relating to devices for carrying electric cables, wires, and the like." D. P. Regan. Dated September 22nd.

16,881. "Improvements in wireless telegraphy and telephony." S. G. Brown. Dated September 22nd.

16,896. "Electrical fittings for discharging cisterns." J. G. Davidson and J. Don. Dated September 22nd.

16,898. "Improvements in apparatus for electrically transmitting orders or signals, such apparatus being suitable for navigable vessels and other purposes where it is required to transmit a series of signals or orders." G. C. Shanksteb." Dated September 22nd.

16,903. "A new or improved device or apparatus for fixing electric lamps in the sockets of overhead electroliers, brackets, and the like, or for detaching them therefrom." W. V. Biggs. Dated September 22nd.

16,912. "Improvements in or relating to covers or lids of telephone cases or the like." H. A. Jackson. Dated September 22nd.

16,915. "Improvements in the production of filaments for incandescent electric lamps." F. Danneel. Dated September 22nd. (Complete.)

16,916. "Improvements in or connected with electro-magnets." J. Wetter. (The Elektricitäts Aktiengesellschaft, vormals Schuckert & Co., Germany.) Dated September 22nd. (Complete.)

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

Copies of any of these Specifications may be obtained of Messrs. W. P. Thompson and Co., 322, High Holborn, W.C., and at Liverpool, Manchester, and Birmingham, price, post free, 9d. (in stamps).

1898.

58. "Improvements in rail joints for electric railways." M. Barsehall. Dated January 1st, 1898. Relates to rail joints, &c. The rail joints are made as described in Specifications 18,524, 1890; 9,689, 1892; with a short length of rail and with or without an intermediate fishplate. The bond lies in the space left between these parts. Only a single wire is used, but the space on both sides of the fishplate may be used for a double bond. 3 claims.

4,278. "Improvements in or relating to railway electrical signalling apparatus." J. A. Busher. Dated February 21st, 1898. A battery has one pole connected to one of the rails, and the other pole connected through a bell or indicator and switch in the signal cabin, to the line wire, from which branch wires are carried to contact bars located in suitable positions between the rails. The engine is provided with a contact brush adapted to make contact with the contact bar, and with a relay electro-magnet which when energised, releases the spring contact, and so closes a local circuit through the battery, and bell, &c., on the engine. When the brush makes contact with the bar, the main and local circuits are completed, and the bells sounded. The contact is reset by means of a spring push. The bar consists of an insulated conducting strip mounted on a wooden or other base fixed to the sleepers. The brush consists of a number of contact strips pivoted to a frame, and normally held vertical by springs the frame being suspended from links and connected to a lever, so that it can be raised into an inoperative position. The brush and bar may be kept clear of the frost or snow by steam discharged from the engine pipes, or the bar may be heated in any other way for the same purpose. 3 claims.

11,604. "Improvements in and connected with the electro-metallurgic production of iron, steel, and their alloys, with chromium, tungsten, nickel, manganese, and the like." E. Stassano. Dated May 23rd, 1898. Relates to obtaining iron or steel, or an alloy thereof, with chromium, tungsten, nickel, manganese, and the like. The ore is first prepared as follows:—It is hand selected, pulverised, sifted, washed, and separated from gangue by a magnetic separator, an analysis is then made, and the required amount of lime, silica, and carbon added; 5 to 10 per cent. of water is next mixed therewith, and the whole is pressed into cakes, which are afterwards broken up. If an alloy is to be formed, the oxides of the metal to be added are mixed and melted with the ore. The mixture is reduced in an electric furnace formed of a double cone with a pot beneath, two adjustable carbon electrodes, a tap-hole for the liquid metal or alloy, two outlets for gases, and a feeding-hopper having a valve operated by a lever. 3 claims.

22,071. "Improvements in safety devices for use with electric cables." J. A. Fleming. Dated October 20th, 1898. Safety devices such as cut-outs or lightning arresters are arranged either as a bridge across the circuit or from one line to earth. The apparatus consists essentially of a single or multiple spark gap, arranged in series with one fusible cut-out of a series. The fuse wires are either strained by springs or by weighted levers. In the former case a spring controlled arm, connected to the second lead or earth, moves round against the fuse plates, and is released, whenever a fuse is broken. Before reaching the last fuse, an alarm circuit is closed. In the case of the weighted lever arrangement, the lever in falling after a fuse blows, completes the circuit for the next fuse. The fuse wires may be enclosed in tubes containing powdered chalk, &c. 4 claims.

22,080. "Improvements in protecting static voltmeters." The British Thomson-Houston Company, Limited. (E. M. Howlett.) Dated October 20th, 1898. Electrostatic measuring instruments are connected with supply mains by high resistances, which may be inductive to prevent passage of destructive currents if discharge occurs between the opposed parts of the instruments, or if leakages occur. The opposed parts of the instruments may then be safely placed near together. The application of the invention to ground indicators for high pressure alternating current circuits is mentioned. 2 claims.

22,081. "Improvements in means for adjusting the reluctance of magnetic circuits." The British Thomson-Houston Company, Limited. (E. Thomson.) Dated October 20th, 1898. For the purpose of adjusting the reluctance of a magnetic circuit, there is interposed in the circuit a body of laminated material, so arranged that the laminæ may be placed either parallel with or at any desired angle to the lines of force. In the former case the reluctance is least; in the latter case it reaches a maximum when the angle is 90°. The invention is shown applied to reactance coils, and to the field magnets of multipolar dynamos. 7 claims.

22,082. "Improvements in trolley cars for electric railways." The British Thomson-Houston Company, Limited. (H. Geisenhoener.) Dated October 20th, 1898. Relates to supports for conductors on electric railways and tramways on the overhead system. The conductor is held on the trolley ear by a wire which is laid in grooves in the conductor and secured by lugs on the car. 7 claims.

22,115. "Improvements in galvanic batteries." E. Baresch, R. M A. Baresch, E. M. Tosler, and W. von Zaborn. Dated October 20th, 1898. Relates to an electrode for Leclanché and like batteries, and consists in making it of a rod of carbon which is forced into a mixture of powdered peroxide of manganese and powdered coke or gas carbon moistened with ammoniacal salts and contained in a bag formed of a piece of seamless hose, the upper end of which is subsequently closed by a cord which is passed through a hole in that part of the carbon rod which lies outside the bag. To form a dry battery this electrode is placed in a zinc cylinder which contains sawdust or the like, impregnated with sal-ammoniac. 5 claims.

22,130. "Improvements in electric railways and tramways on a sectional conductor system." W. G. Heys. (J. J. Heilmann.) Dated October 21st, 1898. Electric railways and tramways on a sectional conductor system with each section supplied by separate generators. In the form shown, three-phase motors are supplied from main conductors and drive generators and exciters on each section, which may correspond with a block section. The generators supply current through insulated sectional conductors to the vehicle motors, and a second set of insulated sectional conductors is used in conjunction with a second collector and switch on the vehicle, to complete the circuit between the exciters and the field coils of the generators. Resistances are placed between the sections of conductor and insulated pieces of the other conductor. Continuous or other current motors, or motors other than electric motors can be used to drive the generators, which may be arranged to supply continuous or other currents. 5 claims.

22,171. "Improvements in insulating devices for the electrodes of accumulators." J. H. Graeber and H. Tobler. Dated October 21st, 1898. The plates are made up of a series of rectangular frames, packed with active material and riveted to conducting strips. The separators which constitute the main feature of the invention consist each of two end blocks with grooves in which the end of the plates rest. In each block is cut a number of inclined notches, in which are placed insulating tiles or slabs of glass, so as to form the sides of the separator. 2 claims.

22,181. "Improvements in electrical conducting mains." J. S. Highfield and J. M. J. Cater. Dated October 21st, 1898. Conductors of various section and covered with a thin layer of compressed fibre are mounted in hard wood. The conductors are provided with longitudinal dove-tail grooves and the outer metallic tube is also provided with grooves corresponding in position with the grooves. The number of the conductors may be varied, and the provisional specification refers to the use of conductors without grooves. Lengths of the main are joined by connecting the conductors covering the ends of the metal tube with a screw-sleeve and filling up the space with insulating material. Branches are taken off by drilling through to the grooves and driving in a metal plug split at the end and provided with a wedge. The plug is enclosed in a metal case, and is separated from the same by a divided wooden sleeve. The branch lead is soldered into the plug, and the metal case filled with insulating material. The provisional specification refers to the plug being screwed into a conductor without a groove. 2 claims.

22,190. "Improvements in joint boxes and switches therefor, in connection with concentric systems of electrical conductors." G. Wilkinson. Dated October 21st, 1898. The junction box is fitted with a switching arrangement for connecting or disconnecting the conductors for testing, &c. The outer box is fitted with ledges for supporting the inner box which contains the switch and connections. The cables are passed in through conduits and enter the inner box through tapered nozzles packed with insulating material. The outer conductors are clamped to a base and are connected by bars which may be removed from testing, &c., to the branches. The inner conductors are fitted with contact forks adapted to engage with contacts carried by a ring mounted on a rotary disc and so forming the switch. The insulating disc is connected to a metal top plate fitted with an insulating ring to protect the contacts. This plate is earthed through a spring connected to the box through the screw. A wooden ring is provided for covering the connections. With this arrangement the branches may be entirely disconnected without affecting the mains. 4 claims.

22,252. "A telephonic apparatus for use on vessels for determining the position of bodies moving outside of same." M. R. D'Asar. Dated October 22nd, 1898. Apparatus for use on board ship to determine the position of bodies moving outside the same. A number of reflectors are mounted in a partially exhausted case attached to the ouside of the vessel below the water line. The reflectors are provided with central apertures connected by pipes with a cylinder, the connections being in an axial line. A second cylinder rotates in the cylinder, and has a similar series of openings on an axial line and a corresponding series arranged in spiral form. The interior of the second cylinder is connected to the telephonic apparatus. A pointer is moved over a scale by the bevel gearing on the driving shaft. 7 claims.

22,344. "Improvements in electric arc lamps." H. Delavan and F. F. Brevat. Dated October 24th, 1898. (Date claimed under Act, March 24th, 1898.) Arc lamps having supply chambers for carbons which are withdrawn, and fed to the arc automatically as described in Specification No. 4 934, A.D. 1897, are provided with feed rollers for this purpose, avoiding the use of carbons formed to fit together. The carbons in a chamber are passed toward the outer side of the chamber and against a stop by the extended and flattened end of a spiral spring. The outer carbon is situated between toothed rollers carried by a fixed support and a lever. The lever normally rests on the stop, and it supports two pawls connected by a link, and a screen-pressed lever with the core of a shunt solenoid. The rollers are movable in slots in the lever under spring control. The lamp contains an electro-magnetic switch, connected in parallel with the carbons, and acting so that when the difference of potentials at the terminals rises, the solenoid is excited, and raising the core and pawls, it causes the rollers to grip and push down the outer carbon. These movements occur repeatedly, if necessary. Springs prevent reverse motion of the rollers. The arc is struck, and its length is regulated by series solenoids and jaws. 1 claim.

22,419. "Improvements in telephone transmitters." M. Byng. Dated October 25th, 1898. Microphones, of the type in which carbon granules are held against a carbon diaphragm by a cupped carbon block, have that block formed with a back central opening and lateral openings. The openings are filled with lead, and a double-threaded screw stud made secure therein, or a serrated shank to the stud may be embedded therein. The carbon diaphragm is mounted between the front and back cases. The stud passes through an insulating bush, and the carbon block is connected by a metal block to a binding screw. 2 claims.

22,449. "Improved combined brake-pipe and electrical coupling for railway trains." A. G. Wild. Dated October 25th, 1898. Relates to combined brake-pipe and electrical couplings for railway vehicles. The coupling is formed of two-flanged pipes of the usual kind, faced with packing rings. The half-couplings are connected together by linking the hooks and then sliding the lugs into the corresponding slots. Fixed to each lug, but insulated therefrom, is an electric contact to which are connected the conductors. On bringing the two halves of the coupling together, the spring contacts touch and complete the circuit. Wires are arranged for the return current. In the modification, the projecting portion of each U-shaped electric contact takes the place of the lug, and entering the recess in the opposite flange, holds the half-couplings together, and at the same time electrically connects the wires. 3 claims.

22,461. "Improvements in primary batteries." J. Y. Johnston. (H. J. Dercum.) Dated October 25th, 1898. The battery comprises an outer casing of lead in which is fitted a number of porous partition plates of carbon or earthenware formed by casting lead around plates of carbon or earthenware, having notches in them into which the lead also enters. Each pair of plates is formed into a closed compartment for the depolarising liquid, by uniting them together by strips of lead, which are burnt to the lead frames of the plates. Each pair of compartments is united together by lead strips so as to form compartments open at the top and bottom, into which the zinc plates and the exciting liquid are placed, the other electrode being constituted by the lead parts of the battery, which are all burnt together, and to a bottom piece of lead which is filled with an insulating composition. On this is placed a lead plate, on which rest the lower ends of the zinc plates, and which has a screwed connection passing through an insulating nipple to the exterior of the battery. Rubber bands are placed around the compartments, and around some or all of the zinc plates. The depolarised liquid, which is acidified sodium bi-chromate, is supplied to the compartments through passages communicating with an external channel, and it is drawn off through passages communicating with an external channel. The exciting liquid, which is dilute sulphuric acid, is similarly supplied through passages and a channel and drawn off through a channel. The external connections to these channels consists of T-headed nipples, which may be connected by rubber tubing to similar nipples on other batteries in order that a number of batteries may be supplied from the same source. An air exit is provided for the compartments. The batteries may have a cover provided with a central gas exit. 18 claims.

22,537. "Improvements in or connected with electric push buttons." G. Markt. Dated October 26th, 1898. Pushes constructed to resemble tumbler switches. The push slides in a guide formed in a bridge on which the dome screws and forces the spring contact against the fixed contact. 2 claims.

22,545. "Improvements in automatic telephone exchanges." W. P. Thompson. (The Strowger Automatic Telephone Exchange.) Dated October 26th, 1898. Relates to an automatic exchange for telephonic working in which each subscriber is provided with a selecting apparatus consisting of grouped contacts divided into groups of ten bars, each bar being curved and having ten contacts. The contacts are acted upon by radial wipers rigidly mounted upon, but insulated from, the shaft. The shaft is operated by a circular feed rack for longitudinal movement, and by an elongated pinion for rotary selection. The pinion carries an arm which engages with one of the pegs of the subsidiary switch of which the pegs agree in number with and are connected by wires to the wiper arms. The feeds are operated by magnets through the requisite levers and pawls, and two single-coil magnets are arranged with a view to ensuring the proper sequence in the various movements, and for preventing interference by a third subscriber during any conversation. Tripping devices are also described for releasing the feed pawls and allowing the apparatus to return to its normal position on completion of a conversation. The shaft is in a vertical position, and is shown with a partially-supporting spring acting through the lever and pivoted rod acting as a bottom bearing and is provided with a spring which serves to rotate the shaft to its normal position. The contact bars are arranged with external hooks, so that the interconnecting insulated conductors can be bared, twisted round the same, and soldered. Each subscriber is provided with a set of three keys lettered for "hundreds" "tens" and "units" besides the ordinary signalling apparatus. 14 claims.

have duly realised how much the amount comes to at

Fleming were conducted between two stations 20 mi